

PROJECT MANUAL

SPECIFICATIONS

LOOPERS WASTEWATER TREATMENT PLANT DEWATERING FACILITY UPGRADES



DALTON, GEORGIA

BARGE NO.: 36085-20
DATE: JUNE 2020

**LOOPERS WASTEWATER
TREATMENT PLANT
DEWATERING FACILITY
UPGRADES**

**DALTON UTILITIES
DALTON, GEORGIA**

The following licensed professionals are responsible for the various portions of the project manual by which their seal, signature and date is affixed:

Division 00 - Procurement and Contracting Requirements

Division 01 - General Requirements

Division 02 - Existing Conditions



Wayne Price, PE

Division 03 - Concrete

Division 05 - Metals



Brian Wood, PE

Division 09 - Finishes



Raymond Cordon, PE

Division 22 - Plumbing
Division 23 - Heating Ventilation and Air Conditioning



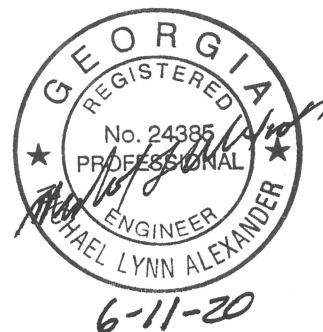
Kevin Smith, PE

Division 26 - Electrical



George Boyd, PE

Division 40 - Process Integration, Except
Section 40 60 00
Section 40 60 00.01



Mike Alexander, PE

Division 40 - Process Integration
40 60 00
40 60 00.01



6-8-2020

David Zimmer, PE

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**ADVERTISEMENT FOR BIDS
FOR
LOOPERS WASTEWATER TREATMENT PLANT
DEWATERING FACILITY UPGRADE
FOR
THE BOARD OF WATER, LIGHT AND
SINKING FUND COMMISSIONERS
OF THE
CITY OF DALTON, GEORGIA
D/B/A DALTON UTILITIES**

Sealed Proposals for the LOOPERS WASTEWATER TREATMENT PLANT DEWATERING FACILITY UPGRADE for the BOARD OF WATER, LIGHT AND SINKING FUND COMMISSIONERS OF THE CITY OF DALTON, GEORGIA D/B/A DALTON UTILITIES (“Owner”) will be received at the Dalton Utilities Administration Building, 1200 V.D. Parrott Jr. Parkway, Dalton, Georgia 30721 until **2:00 P.M.** local time **August 6, 2020**, at which time they will be publicly opened and read aloud. Bids shall be addressed to “Attn: Leslie Rush.”

Bidder Pre-Qualification: Pre-qualification of Bidders for the Project is required. The Pre-Qualification requirements are a part of the Instructions to Bidders of the Project Manual. Applications for pre-qualification for bidding will be received at the Dalton Utilities Administration Building, 1200 V.D. Parrott Jr. Parkway, Dalton, Georgia 30721 until 4:00 P.M. local time **July 7, 2020**. Only Bids submitted by properly pre-qualified Bidders will be opened.

A mandatory Pre-Bid Conference is scheduled for **July 16, 2020** at 10:00 A.M. local time, at the Dalton Utilities Administration Building, 1200 V.D. Parrott Jr. Parkway, Dalton, Georgia 30721. Attendance is mandatory. A Bid submitted by a Bidder which did not attend the Pre-Bid Conference will not be opened and will be returned to the Bidder.

Scope of Work: The work to be done (hereinafter referred to as “Work”) consists of furnishing all materials and equipment, and performing all labor necessary for the construction of, but not limited to, the following major components: replacing two existing centrifuges with two Flottweg Model C5E centrifuges including miscellaneous piping and appurtenances; constructing sludge conveyor improvements including replacing the vertical conveyor with an inclined conveyor section, new loading station, and rehabilitation of the existing conveyor system; constructing polymer system improvements including two new polymer blending units; performing building improvements, including replacement of all HVAC systems, structural modifications, repainting of the entire building, miscellaneous corroded metal repair, and replacing all electrical switchgear, panels and distribution wiring systems; and improvements to the SCADA and instrumentation systems.

The Contractor shall be responsible for providing all labor, equipment, and materials to complete this Project. The Contractor shall provide its own generators or make arrangements for temporary power.

The Contractor shall be responsible for the cost of permits or licenses required to complete the work. The Contractor shall complete all necessary clean-up and restoration work such that post

construction conditions are equal to or better than those conditions that existed prior to any construction activity occurring.

The Owner is authorized to issue change orders, without the necessity of additional requests for bids, within the scope of the Project when appropriate or necessary in the performance of the contract. No additional work shall be performed unless authorized by the Owner.

Time Allotted: All work, as specified herein, shall be substantially completed within 270 calendar days of the notice to proceed, with completion within 300 calendar days. This notice will be issued at the preconstruction meeting which will be scheduled shortly after the final contracts have been executed.

Bids: Bids shall contain complete prices for all labor, equipment, and construction materials necessary to complete the Work.

Contractor's License: All bidders must possess any and all licenses and permits as may be required by applicable federal, state and/or local law/ordinances.

Performance and Bid Bond: A bid bond will be required in the amount of 10% of the total bid amount. A contract performance bond and a payment bond, in an amount equal to one hundred percent (100%) of the contract price, will be required of the successful bidder.

Withdrawal of Bids: Except as provided in O.C.G.A. Section 36-91-43, no submitted bid may be withdrawn for a period of sixty days after the scheduled closing time for the receipt of bids.

Additional Instructions to Bidders, Drawings, Specifications and Contract Documents: Additional instructions to bidders, drawings, specifications, and other contract documents may be examined at Dalton Utilities, Department of Watershed Services, 1200 V.D. Parrott Jr. Parkway, Dalton, Georgia. Bidding Documents, consisting of Drawings, Project Manual and documents required to be submitted with the Bid Form, may be obtained at:

Bidding.BargeDesign.com
Lellyett and Rogers Company
615-250-9145

Neither Owner nor Engineer will be responsible for full or partial sets of Bidding Documents obtained from other sources. The cost of the Bidding Documents is \$500.00, non-refundable, for each set. This includes two-day shipping; other shipping will be at Bidder's expense. No partial sets will be sold.

Acceptance or Rejection of Bids: The right is reserved to accept or reject any and all bids and to waive technicalities and informalities.

Statutory Requirements: Notwithstanding any provision of this advertisement, all proposals must also comply with the minimum applicable requirements of Chapter 91 of Title 36 of the Official Code of Georgia Annotated.

E-Verify Requirements: All contractors and subcontractors performing work for Dalton Utilities must participate in the E-Verify Program pursuant to the Georgia Security and Immigration Compliance Act (SB 529).

THE BOARD OF WATER, LIGHT AND SINKING FUND
COMMISSIONERS OF THE CITY OF DALTON, GEORGIA
D/B/A DALTON UTILITIES

By: Tom Bundros, Chief Executive Officer

**INSTRUCTIONS TO BIDDERS
FOR
LOOPERS WASTEWATER TREATMENT PLANT
DEWATERING FACILITY UPGRADES
FOR
THE BOARD OF WATER, LIGHT AND SINKING FUND COMMISSIONERS
OF THE
CITY OF DALTON, GEORGIA
D/B/A DALTON UTILITIES**

Bids received until **2:00 P.M.**, Local Time, **August 6, 2020**

INSTRUCTIONS TO BIDDERS

I. Definitions:

Unless otherwise defined in this document, capitalized terms have the meaning defined in the Contract.

II. Evaluation of Bidders:

The Contract will be awarded pursuant to O.C.G.A. Section 36-91-21 to the lowest responsible and responsive bidder whose bid meets the requirements and criteria set forth in the invitation for bids. A responsible bidder is a person or entity that has been deemed pre-qualified, as determined by Dalton Utilities ("Owner"). A responsive bidder is a person or entity that has submitted a bid that conforms in all material respects to the requirements set forth in the invitation for bids as determined by the Owner. Factors to be considered may include, but are not necessarily limited to the following:

A. Determination of Contract Awardee:

1. The Owner will determine which is the lowest responsible and responsive bidder based on:
 - a) Completeness: The completeness and regularity of the bid form.
 - b) Exclusions: Bid form without exclusions, alternatives, or special conditions.
 - c) Lowest bid shall be determined on Base Bid amount, not including alternates. In the event of a tie for lowest bid, the lowest bid will be determined by a coin flip, with the bidder whose corporate office is closest to the headquarters of Dalton Utilities making the call.
2. Bidder's ability to begin the Work on this Project within four weeks upon the award of the Contract with sufficient resources to complete the Project by the Completion Date and maintain timely progress as determined by the Owner.

B. Qualifications of Bidders:

1. The bidder must have sufficient resources (including but not limited to labor, equipment, and financial resources) to complete the Project by the Completion Date and maintain timely progress as determined by the Owner. The bidder should consider existing commitments in determining adequate personnel and equipment availability throughout the Project so as to stay on schedule and finish all Work by the Completion Date.
2. The bidder must have a damage prevention program in place providing for coordination of excavating with the Utilities Protection Center of Georgia and have the provisions for a readily available location for the excavation permit on site for the particular excavation. This information shall be delivered in writing prior to commencement of Work on the Project.

III. Site Examination and Sub-Surface Conditions:

The bidder is expected to examine the location of the Project and to inform itself fully as to the existing conditions; the character of equipment and facilities needed preliminary to, and during the performance of the Work; the general and local conditions; and all other matters that can in any way affect the Work to be done.

IV. Interpretation of Drawings and Specifications:

If any entity contemplating submitting a bid for the Project has any question as to the true meaning of any part of the Drawings, Specifications, or other Contract Documents, or as to the scope of any part of the Work, it shall submit to the Engineer (email: raymond.cordon@bargedesign.com, phone 678-515-9416) a written request for an interpretation thereof. The entity submitting the request will be responsible for its prompt delivery in ample time for an interpretation to be issued before the bid opening date. No questions will be answered within 72 hours of bid opening. Interpretations of the documents will be made only by addendum. The Owner will not be responsible for other interpretations of the documents. The bids shall be opened publicly and evaluated by the Owner without discussion with the bidders.

V. Complete Work Required:

The Specifications, the Drawings, and all Contract Documents are essential parts of the Contract. Application requirements occurring in one are as binding as though occurring in all. All requirements are intended to be complementary and to describe and provide for the complete Work.

VI. Permits, Easements and Rights-of-Way

- A. All anticipated federal, state, or local permits required for the Project, which are the responsibility of the Owner, have been obtained.

- B. All rights-of-way and easements required for the Project, which are the responsibility of the Owner, have been obtained.

VII. Bidder Pre-Qualification:

A. Pre-Qualification Determination

1. Applicants may not be deemed pre-qualified if:
 - a. The Applicant fails to submit a responsive Application, including failing to provide all required documentation;
 - b. The Applicant fails to meet all the Technical Experience Requirements;
 - c. The Applicant fails to meet all the Corporate Experience Requirements;
 - d. The Applicant, or any of its affiliated companies, is a party to more than one Application;
 - e. Reasonable grounds exist that Applicant is involved in collusion among other applicants; or
 - f. The Applicant fails to execute the Disclosure Affidavit.
2. Final determination of Applicant's pre-qualification status rests solely with Dalton Utilities.

B. Qualification Criteria

1. Technical Experience Requirements
 - a. The Applicant has successfully completed construction of at least three projects at a water or wastewater treatment facility.
 - b. Each project must have had a constructed value of not less than \$2 million dollars.
 - c. At least one of the projects must have had a constructed value of not less than \$2.5 million dollars.
 - d. At least one of the projects must have included constructing solids dewatering facilities.
 - e. Each of the projects must have been completed since January 1, 2010. At least one of these projects must have been completed since January 1, 2015. Projects currently under construction will not qualify.
 - f. At least 30 percent of the labor-related items on each project must have been completed by the Applicant's own work force.
2. Corporate Experience Requirements
 - a. The Applicant has operated under the current corporate name for the last five years.
 - b. The Applicant currently has sufficient bonding capacity to provide performance and payment bonds, both in the amount of 100 percent of the contract amount.
 - c. The Applicant has access to adequate equipment to construct the project.

- d. The Applicant has not defaulted on a project or failed to complete a project within the last ten years.
 - e. The Applicant has not filed for bankruptcy nor been judged bankrupt at any time over the last nine years.
 - f. The Applicant has a history of completing projects consistently on time and within the bid amount.
 - g. The Applicant has never abandoned a project (even temporarily) during a dispute.
 - h. The Applicant does not have a history of being involved in litigation or filing claims against Owners, Construction Contract Administration Firms or Design Firms.
 - i. The Applicant has available project management personnel with at least ten years of experience on projects with the technical characteristics listed under Technical Experience Criteria.
 - j. The Applicant, is not, nor any of its affiliated companies, currently involved in a dispute, formal claim, or litigation with the Owner, or with any authority or organization with which the Owner has a vested interest.
 - k. The Applicant is a Licensed Utility Contractor in the State of Georgia.
3. The Applicant shall fully execute and submit the Disclosure Affidavit. Use the form at the end of this section of the Specifications.

C. Required Documentation

1. Technical Experience

- a. For each project submitted as documentation of meeting the Technical Experience Criteria, provide all the information specified in Paragraphs b through i below. (Use the form at the end of this section of the Specifications or a similar format.)
- b. Name of project as bid, name of Owner, name of Design Firm, name of Construction Contract Administration Firm.
- c. Name, position or title, address and telephone number of contact person currently employed by each of the above.
- d. Percent of labor-related items performed by the Applicant's own work force.
- e. A complete description including sizes, quantities, structures, and major items of equipment.
- f. Names and contact information for major subcontractors, including earthwork, reinforced concrete, HVAC, electrical, and instrumentation and control. If work was self-performed, please indicate such.
- g. Names and contact information for manufacturer representatives of major equipment items provided on project.
- h. The bid amount and final cost to Owner, with an explanation of cost overrun, if any, including change orders.
- i. The contract time as bid, actual time to complete project and completion date, with an explanation of time overrun, if any.

2. Corporate Experience

- a. Provide name, address and telephone number of Applicant's corporate headquarters, regional offices, subsidiaries and affiliates, if any. Provide name, title, and biographical summary of pertinent corporate officers. Provide a statement that Applicant has operated under the current corporate name for the last five years.
- b. Provide a statement of bonding capacity, name of surety company, with agent contact persons, and telephone numbers. Define current maximum approved bonding program, allowable single project limit and current bonded work backlog.
- c. Provide a statement that Applicant has not defaulted on a project nor failed to complete a project within the past ten years. If this is not the case, explain.
- d. Provide a statement that Applicant has not filed for bankruptcy or been judged bankrupt at any time over the past nine years. If this is not the case, explain.
- e. Provide a statement that Applicant has not been involved in liquidated damages in the past five years. If this is not the case, explain.
- f. Provide a statement that the Applicant has never abandoned a project, even temporarily, during a dispute. If this is not the case, please explain.
- g. Provide a statement whether Applicant has or has not been involved in litigation as a plaintiff against an Owner, Design Firm or Construction Contract Administration Firm, or served the Owner with a claim for additional compensation prepared by an attorney or a claims consultant, excluding routine change order requests, in the past five years. If Applicant has, explain. List any lawsuits or administrative actions to which the Applicant is currently a party or has been a party (either as a plaintiff or defendant) during the past ten years. For each suit, list all parties and indicate whether any party was a bonding company, insurance company, an Owner, or other. Identify the project giving rise to the suit or administrative action; explain the basis of the claim, and whether a settlement was reached or a judgment entered into for or against the Applicant, or the Applicant's bonding company or insurance company.
- h. Provide experience of proposed on-site project manager and/or field superintendent who would be involved in this project. Experience can be from previous employment but must be pertinent to technical characteristics listed under Technical Experience Criteria. If your firm is the successful bidder, at least one of these key personnel must be actively involved in the day-to-day operations of the construction of this project. Also provide a staffing plan identifying other key personnel anticipated to be assigned to the Project. Provide a brief description and title for each position identified in the staffing plan.
- i. Provide a statement that the Applicant, as well as all of its affiliated companies, is not involved in any dispute, formal claim, or litigation with the Owner, nor any authority or organization with which the Owner has a vested interest. If this is not the case, please explain.
- j. Include a copy of the Applicant's Georgia Utility Contractor License.

D. Supplemental Information and Requirements

1. Provide a list of all projects under contract over the last five years, with a construction contract amount in excess of \$2 million. Provide all information on projects as required on Technical Experience Project Information Form, up to a maximum of ten projects. If there are more than ten projects, applicant need only provide Contract Title, Project Owner, Contract amount and dates of performance.
2. List all other projects, up to a maximum of ten projects, currently under contract, the current contract amounts and scheduled completion dates. Provide all information on projects as required on Technical Experience Project Information Form, up to a maximum of ten projects.
3. The Owner will not be liable in any way for any costs incurred by any Applicant in the preparation of its Pre-Qualification Application nor participation in any discussions.
4. The Owner reserves the right to accept or reject any or all Pre-Qualification Applications. The Owner, upon receipt of the Application, shall have the right to investigate work performed by the Applicant on projects referenced by the Applicant, or any other projects performed by the Applicant. Investigations will be performed by Owner's personnel or their representatives as deemed appropriate by the Owner, which may include site visits and interviews with project Owners and Construction Contract Administration staff.
5. If the Applicant does not meet all the corporate and technical experience criteria, additional consideration may be given as follows:
 - a. If the corporate name of the Applicant is a result of an acquisition or a merger, the Applicant may use the corporate and technical experience of the parent corporation, a sister corporation or a subsidiary corporation, if satisfactory evidence can be provided to demonstrate that essentially the same core management team and staff which created the experience is directly involved in the day-to-day operations of the Applicant.
 - b. If the corporate name of the Applicant is a result of the formation of a subsidiary by a parent company in order to compete in a different market, e.g. union versus non-union territories, the Applicant may use the corporate and technical experience of the parent corporation, a sister corporation or a subsidiary corporation, if satisfactory evidence can be provided to demonstrate that essentially the same core management team and staff which created the experience is directly involved in the day-to-day operations of the Applicant.
6. Applications from Joint Ventures will be rejected.
7. Application Format: The Application must include responses to all information requested. The Application shall address required documentation in the order identified above, indexed and clearly identified. Additional data may be submitted as deemed appropriate to support or augment the required documentation. Submittal shall be prepared on standard 8-1/2" x 11" letter size paper, with text on one side, using 11-point or larger font, and bound on the left side. No page limitation has been established for the application submission, but non-pertinent "boilerplate" materials are discouraged.

8. Should any Applicant not be deemed pre-qualified by the Owner, the Applicant may respond within three business days of being notified of pre-qualification status to the Chief Executive Officer requesting reasons for not being deemed pre-qualified. The Applicant may then provide further written information in an attempt to correct such deficiencies within three business days of receiving reasons for not being deemed pre-qualified. This will be an informal appeals process.
9. Applicants will be advised of their Application approval/rejection by July 14, 2020.

DISCLOSURE AFFIDAVIT

The undersigned hereby authorizes and requests any person, firm, or corporation to furnish any information requested by the local public agency in verification of the recitals comprising this Application for Bidder's Pre-Qualification. By this signature the signer affirms that the information provided herein is true and correct to the best of his/her knowledge and belief.

Applicant: _____

By: _____
(name signed)

(name printed or typed)

Title:

Date: _____

Technical Experience Project Information Form

Project Title: _____

Project Description: _____

Major Subcontractors:

Earthwork: _____

Reinforced Concrete: _____

HVAC: _____

Electrical: _____

Instrumentation & Controls: _____

Major Equipment Suppliers: _____

Project Owner:

Owner Name: _____

Contact Person: _____

Phone Number: _____

Design Firm:

Company Name: _____

Contact Person: _____

Phone Number: _____

Construction Contract Administration Firm:

Company Name: _____

Contact Person: _____

Phone Number: _____

Percentage of Work performed by Applicant: _____ %

Contract Amount:

- Initial: _____

- Final: _____

Contract Time

Initial: _____

Final: _____

Completion Date: _____

**LOOPERS WASTEWATER TREATMENT PLANT
DEWATERING FACILITY UPGRADES**

ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to:

Board of Water, Light and Sinking Fund Commissioners of the City of Dalton, Georgia
d/b/a Dalton Utilities
Dalton Utilities Administration Building
1200 V.D. Parrott Jr. Parkway
Dalton, Georgia 30721

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

ARTICLE 2 – BIDDER’S ACKNOWLEDGEMENTS

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

ARTICLE 3 – BIDDER’S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

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

<u>Addendum No.</u>	<u>Addendum Date</u>	<u>Addendum No.</u>	<u>Addendum Date</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

B. 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.

C. Bidder 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.

- D. Bidder has carefully studied all: (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 SC-4.02 as containing reliable "technical data," and (2) reports and drawings of Hazardous Environmental Conditions, if any, at the Site that have been identified in SC-4.06 as containing reliable "technical data."
- E. 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.
- F. Based on the information and observations referred to in Paragraph 3.01.E 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.
- G. 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.
- H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.
- I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.
- J. Where this Bid Form contains the provision for a bid based on a lump sum price, the Bidder shall be responsible for having prepared its own estimate of the quantities necessary for the satisfactory completion of the Work specified in these Contract Documents and for having based the lump sum price bid on its estimate of quantities.

ARTICLE 4 – BIDDER'S CERTIFICATION

4.01 Bidder certifies that:

- A. 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;
- B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;
- C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

- D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:
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;
 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 non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;
 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, non-competitive levels; and
 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.

ARTICLE 5 – BASIS OF BID

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

Item No.	Description	Estimated Qty.	Unit	Unit Price	Total Price
1.	Furnishing all products, materials and equipment and performing all labor necessary to complete and put into operation the Loopers WWTP Dewatering Facility Upgrades, including all work shown on the Drawings and/or specified and not included in Items 2 through 4 below, the total amount of:	Lump Sum		\$	
2.	Cash Allowances				
a.	Materials Testing	ALLOWANCE			\$25,000.00
3.	Owner's Contingency Allowance	ALLOWANCE			\$100,000.00
4.	Equipment Allowance				
a.	Instrumentation and SCADA System	ALLOWANCE			tbd
b.	Dewatering Equipment	ALLOWANCE			\$696,947.00
c.	Sludge Conveyance Equipment	ALLOWANCE			\$280,833.00

BID TOTAL, ITEMS 1 THROUGH 4, INCLUSIVE, THE AMOUNT OF _____

_____ Dollars (\$ _____)

Bidder acknowledges Unit Prices have been determined in accordance with Paragraph 11.03.C of the General Conditions.

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.

ARTICLE 6 – TIME OF COMPLETION

6.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 7 – ATTACHMENTS TO THIS BID

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

- A. Bid Bond
- B. Non-Collusion Affidavit of Prime Bidder
- C. Corporate Certificate
- D. Statement of License Certificate
- E. Georgia Security and Immigration Compliance Act Affidavits (E-Verify Affidavit)

ARTICLE 8 – DEFINED TERMS

8.01 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.

ARTICLE 9 – BID DATA

9.01 The Bidder shall designate below the one manufacturer for each product to be furnished and installed if awarded the work with the understanding that no changes or substitutions will be considered for these manufacturers unless directed by the Owner. The Bidder understands that if this information is not provided, offering products meeting all specification requirements and having the approval of the Engineer, then the Owner reserves the right either to determine the Bidder non-responsive and reject the Bid or to designate the manufacturer of the products to be provided which will meet all specification requirements, which Owner-designated manufacturer products must be furnished by the Bidder at no increase in the Contract Price.

Major Product or System Schedule		
Section	Description	Manufacturer/Supplier
26 24 13.13	Switch Gear	ABB/General Electric Company
26 24 16		Eaton
		Siemens
		Square D

ARTICLE 10 – BID SUBMITTAL

10.01 This Bid submitted by:

An Individual

Name (typed or printed): _____

By: _____ (SEAL)
(Individual's signature)

Doing business as: _____

Attest: _____
(Notary)

Name (typed or printed): _____

A Partnership

Partnership Name: _____ (SEAL)

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

Name (typed or printed): _____

Attest: _____
(Signature of another Partner)

Name (typed or printed): _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____

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

By: _____
(Signature)

Name (typed or printed): _____

Title: _____
(CORPORATE SEAL)

Attest: _____
(Signature of Corporate Secretary)

Name (typed or printed): _____

All Bidders shall complete the following:

Bidder's Business address: _____

Phone: _____ Facsimile: _____

Primary Contact: _____

Primary Contact E-mail: _____

Submitted on: _____, 20____.

This document was prepared in part from material (EJCDC C-410 Suggested Bid Form for Construction Contracts) which is copyrighted as indicated below:

Copyright © 2007 National Society of Professional Engineers
1420 King Street, Alexandria, VA 22314-2794
(703) 684-2882
www.nspe.org

American Council of Engineering Companies
1015 15th Street N.W., Washington, DC 20005
(202) 347-7474
www.acec.org

American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400
(800) 548-2723
www.asce.org

Associated General Contractors of America
2300 Wilson Boulevard, Suite 400, Arlington, VA 22201-3308
(703) 548-3118
www.agc.org

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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*):

Board of Water, Light and Sinking Fund Commissioners of the City of Dalton, Georgia
d/b/a Dalton Utilities
1200 V.D. Parrot Jr. Parkway
Dalton, Georgia 30721

BID

Bid Due Date:

Description (*Project Name*): LOOPERS WASTEWATER TREATMENT PLANT DEWATERING FACILITY

BOND

Bond Number:

Date (*Not earlier than Bid due date*):

Penal sum _____ \$ _____
(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

BIDDER

SURETY

Bidder's Name and Corporate Seal (Seal) Surety's Name and Corporate Seal (Seal)

By: _____
Signature

By: _____
Signature (Attach Power of Attorney)

Print Name

Print Name

Title

Title

Attest: _____
Signature

Attest: _____
Signature

Title

Title

Note: Above addresses are to be used for giving any required notice. Provide execution by any additional parties, such as joint venturers, if necessary.

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 Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.
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 of 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.

Non-Collusion Affidavit of Prime Bidder

STATE OF _____

COUNTY OF _____

_____, being first duly sworn, deposes and says that:

He is _____ of _____ the Bidder that has submitted the attached Bid. He is fully informed respecting the preparation and contents of the attached Bid and of all pertinent circumstances respecting such Bid;

Such Bid is genuine and is not a collusive or sham Bid;

Neither the said Bidder nor any of its officers, partners, owners, agents, representatives, employees or parties in interest, including this Affiant, has in any way colluded, conspired, connived or agreed, directly or indirectly with any other Bidder, firm or person to submit a collusive or sham Bid in connection with the Contract for which the attached Bid has been submitted or to refrain from bidding in connection with such Contract, or has in any manner, directly or indirectly, sought by agreement or collusion or communication or conference with any other Bidder, firm or person to fix the price or prices in the attached Bid or of any other Bidder, or to fix any overhead, profit or cost element of the Bid price or the Bid price of any other Bidder, or to secure through any collusion, conspiracy, connivance or unlawful agreement any advantage against the Board of Water, Light and Sinking Funding Fund Commissioners of the City of Dalton or any person interested in the proposed Contract; and

The price or prices quoted in the attached Bid are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees, or parties in interest, including this Affiant.

(Signed) _____

(Title) _____

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

My Commission Expires: _____

(Notary Public)

(SEAL)

CORPORATE CERTIFICATE

I, _____ certify that I am the Secretary of the corporation named as Contractor in the foregoing proposal; that _____, who signed said proposal in behalf of the Contractor was then _____ of said corporation; that said proposal was duly signed for and in behalf of said corporation by authority of its Board of Directors, and is within the scope of its corporate powers; that said corporation is organized under the laws of the State of _____ and its registered and in good standing with the _____ Secretary of State.

This ____ day of _____, 20__.

(Signed)

(SEAL)

Statement of License Certificate**STATEMENT OF LICENSE CERTIFICATE**

Each Contractor bidding shall fill in and sign the following:

This is to certify that _____ (“Contractor”) has fully complied with all the requirements of the Georgia State Construction Industry Licensing Board Laws and Rules. The Contractor’s license number, other information outlined in the Instructions for Bidders, expiration date, and that part of classification applying to the bid shall appear on the envelope containing the Bid, otherwise the Bid will not be considered.

The Georgia State Construction Industry Licensing Board issued to the Contractor, Certificate No. _____, expires on _____.

Signed _____

Printed _____

Title _____

Date _____

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 the Water, Light and Sinking Fund Commission of the City of Dalton, Georgia d/b/a Dalton Utilities 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.C.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

Loopers Wastewater Treatment Plant Dewatering Facility Upgrades
Name of Project

Water, Light and Sinking Fund Commission of the City of Dalton, Georgia d/b/a Dalton Utilities
Name of Public Employer

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

Executed on _____, 20__ in _____ (city), ____ (state).

(Signature of Authorized Officer or Agent)

SUBSCRIBED AND SWORN BEFORE ME ON THIS THE ____ DAY OF _____, 20__.

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 the Water, Light and Sinking Fund Commission of the City of Dalton, Georgia d/b/a Dalton Utilities 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 of receipt of an affidavit from any sub-subcontractor that has contracted with a sub-subcontractor to forward, within five business days of receipt, a copy of such 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 _____, ____ 202__ 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 _____, 202__.

NOTARY PUBLIC

My Commission Expires: _____

Sub-subcontractor Affidavit under O.C.G.A. §13-10-91(b)(4)

By executing this affidavit, the undersigned sub-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 for _____ (*name of subcontractor or sub-subcontractor with whom such. sub-subcontractor has privity of contract*) and _____ (*name of contractor*) on behalf of the Water, Light and Sinking Fund Commission of the City of Dalton, Georgia d/b/a Dalton Utilities 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 sub-subcontractor will continue to use the federal work authorization program throughout the contract period and the undersigned sub-subcontractor will contract for the physical performance of services in satisfaction of such contract only with sub-subcontractors who present an affidavit to the sub-subcontractor with the information required by O.C.G.A. §13-10-91(b). The undersigned sub-subcontractor shall submit, at the time of such contract, this affidavit to _____ (*name of subcontractor or sub-subcontractor with whom such sub-subcontractor has privity of contract*). Additionally, the undersigned sub-subcontractor will forward notice of the receipt of any affidavit from a sub-subcontractor to _____ (*name of subcontractor or sub-subcontractor with whom such sub-subcontractor has privity of contract*). Sub-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 Sub-subcontractor

Name of Project

Name of Public Employer

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

Executed on _____, _____, 202__ 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 _____, 202__.

NOTARY PUBLIC

My Commission Expires: _____

**CONSTRUCTION CONTRACT
FOR
LOOPERS WASTEWATER TREATMENT PLANT
DEWATERING FACILITY UPGRADES**

This construction contract ("Contract") is made and entered into on the _____ day of _____, 20____, by and between THE BOARD OF WATER, LIGHT AND SINKING FUND COMMISSIONERS OF THE CITY OF DALTON, D/B/A DALTON UTILITIES, hereinafter called the "Owner" and _____, hereinafter called the "Contractor".

WITNESSETH:

That for in consideration of the mutual covenants and agreements herein contained and other good and valuable considerations, the receipt and sufficiency of which is hereby acknowledged, the parties hereto do agree as follows:

1. Definitions. As used in this Contract, the following terms are defined as follows:
 - A. "Contract Documents" mean and include the following (and all exhibits and amendments thereto):
 - (i) Advertisement for Bids;
 - (ii) Instructions to Bidders;
 - (iii) Contractor's Bid;
 - (iv) Bid Bond;
 - (v) This Contract;
 - (vi) Performance Bond;
 - (vii) Payment Bond;
 - (viii) General Requirements and Conditions;
 - (ix) Specifications;
 - (x) Drawings;
 - (xi) Notice of Award;
 - (xii) Notice to Proceed; and
 - (xiii) any and all Change Orders.
 - B. "Completion Date" means the date that the Contractor has completed all of its Work regarding the Project and all of the certifications and affidavits have been executed in compliance with the Contract Documents.
 - C. "Project" means Loopers Wastewater Treatment Plant Dewatering Facility Upgrades, as previously described in the Contract Documents.
 - D. "Work" means all materials, supplies, tools, equipment, labor, installation, testing, and all other services necessary for the completion of the Project.
2. Performance of Work by Contractor. The Contractor shall perform all of the Work described in the Contract Documents and comply with the terms therein for the price set forth in the Notice of Award, as may be modified by Change Orders. All Work performed by the Contractor shall be subject to the inspection and approval of the Owner.

3. Changes from Plans and Specifications. Any and all changes from the Contract Plans and Specifications shall be approved by the Owner prior to any changes in the Work being performed. Any and all changes from the Contract Plans and Specifications that result in a change in the scope of work to be performed shall be approved by the Owner in writing by a written Change Order Form, executed by the Owner and Contractor prior to any changes in the Work being performed. For the purpose of this section, a change in the scope of the Work to be performed occurs whenever there is a change in the total price of the Contract or the scheduled Completion Date.

4. Time Period for Performance of Work. The Contractor will be required to complete all work for the project in 300 calendar days unless the time period is modified by a written Change Order that has been executed by the Owner and Contractor. In addition, the Contractor shall achieve completion dates as specified in the Contract Documents for specific tasks to be accomplished as part of the overall Project. Work shall begin on the date specified in the Notice to Proceed. The Contractor shall deploy labor, materials, and equipment such that Work is prosecuted regularly, diligently and uninterrupted, at a rate of progress that will ensure meeting all final or task specific completion dates.

5. Bonds.

A. Performance Bond. The Contractor shall provide a performance bond approved by the Owner in the amount of at least the total amount payable by the terms of this Contract and shall be increased as the total amount payable pursuant to this Contract is increased. The Contractor shall be required to maintain the performance bond in the amount of 100% of the total Contract price until the expiration of the warranty period.

B. Payment Bond. The Contractor shall provide a payment bond approved by the Owner in an amount equal to the total amount payable by the terms of this Contract as may be amended, for the use and protection of all subcontractors, and all persons supplying labor, materials, machinery, and equipment in the performance of this Contract.

6. Compliance with Laws, Regulations, and Contractor Requirements. The Contractor will comply with all applicable laws and with all the requirements of any and all federal, state, and local authorities having jurisdiction over said Work or any matters connected therewith. Contractor will also comply with all requirements contained in General Requirements and Conditions of the Plans and Specifications.

7. Payment for Work Performed. The owner will pay only for Work completed in accordance with the unit prices detailed in the bid and as otherwise herein stated. The Contractor shall submit invoices not later than the tenth day of each month to the Owner for the Work completed during the preceding month and will attach to such invoices a detailed summary of the Work completed during the preceding month and the Contract period to date in a format prescribed by the Owner at the pre-construction meeting. Should the Owner not prescribe a format, the Contractor shall present the Owner with a

format for review and approval prior to the first invoice being submitted. Payment for stored materials will be allowed. Invoices shall only include completed unit items as listed on the bid sheet. All material and Work covered by partial payments made shall thereupon become the sole property of the Owner, but this provision shall not be construed as relieving the Contractor from the sole responsibility for the care and protection of materials and Work upon which payments have been made or the restoration of any damaged work or as a waiver of the right of the Owner to require the fulfillment of all of the terms of the Contract.

Within 30 days after the receipt and approval of the invoices, the Owner will pay the Contractor for the Work covered by said invoices and completed in accordance with this Contract less any applicable retainage as discussed below in Section 8. Contractor agrees to and hereby does waive all rights to interest on retainage.

8. Retainage. The Owner shall retain a maximum of ten percent (10%) of each progress payment described in Section 7 of this Agreement. However, the Owner shall not, except as set forth hereinafter, withhold any additional retainage when fifty percent (50%) of the total Contract price, including Change Orders and other additions to the Contract, is due and the manner of completion of the Work and its progress are reasonably satisfactory to the Owner. If after discontinuing the retention, the Owner determines that the Work is unsatisfactory or has fallen behind schedule, the Owner may resume retention at the previous retention percentage level.

9. Non-Exclusivity. It is understood and agreed that this Agreement is not exclusive and that the Owner shall have the right to employ other persons or entities to perform work for it similar to that herein provided for and shall also have the right to perform such work for itself.

10. Warranty. The Contractor warrants and guarantees for a period of one (1) year from the Substantial Completion Date that the Contractor's Work is free from any and all defects. The Contractor shall promptly make all repairs or other corrections necessary as a result of said defects, including repairs to any other portion of the Project that are necessitated by said defects. If the Contractor fails to promptly make such repairs or corrections, the Owner may make, or contract with a third party to make, said repairs or corrections, and charge the Contractor the cost incurred by the Owner. The Contractor's Performance Bond shall remain in full force and effect during the warranty period. This Section shall survive the termination of this Agreement.

11. Insurance: The Contractor shall provide to the Owner proof and scope of insurance coverage in the form of a certificate of insurance currently in force. The Contractor shall maintain said insurance coverage during the entire time period of the Contractor's performance of this Contract and warranty period. The certificate of insurance must list The Board of Water, Light and Sinking Fund Commissioners of the City of Dalton, Georgia d/b/a Dalton Utilities and the City of Dalton as an additional named insured. The insurance shall not be cancelled or materially altered unless at least 30 days prior

written notice has been given to the Owner. This coverage must include but is not limited to:

A. Worker's Compensation Insurance: Worker's Compensation for every person engaged in any work on the Project.

B. Other coverage as stipulated in the General and Supplementary Conditions.

12. Indemnification: The Contractor shall indemnify and hold harmless the Owner and its agents and employees from and against all claims, damages, losses and expenses including claims for consultants' and attorneys' fees, arising out of or resulting from the failure to perform the Work in a good and workmanlike manner by the Contractor, any subcontractor, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable.

In any and all claims against the Owner, or any of its agents or employees, by any employee of the Contractor, any subcontractor, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the Contractor or any subcontractor under worker's compensation acts, disability benefit acts or other employee benefits acts.

13. Termination of Contract. Provisions for such shall be as contained in the General Conditions of the Contract.

14. Other Remedies. If the Contractor defaults under any of the provisions of the Contract Documents, the Owner shall be entitled to pursue all remedies permitted by law, including but not limited to those remedies set forth elsewhere in the Contract Documents. All remedies of the Owner are cumulative and non-exclusive.

15. Liquidated Damages for Delay in Completion of Project. The Contractor shall proceed with the Work at a rate of progress that will ensure completion of the Project by the Completion Date. It is expressly understood and agreed by and between the Contractor and the Owner, that the time for Project completion described is a reasonable time, taking into consideration the average climatic and economic conditions, and other factors prevailing in the locality of the Project. It is further agreed that time is of the essence of each and every portion of this Project.

If the Contractor shall fail to complete all of the Work required by the Completion Date, or extended time if authorized by a Change Order, then the Contractor shall pay to the Owner the full amount of liquidated damages of \$500.00 for each calendar day that the Contractor shall be in default after the time stipulated in the Contract Documents. See Section 01 35 00 regarding liquidated damages for Substantial Completion. The Contractor acknowledges that the actual dollar amount of liquidated damages is difficult to determine, but the dollar amount of liquidated damages set forth above is a reasonable estimate of said damages incurred by the Owner.

The Contractor shall not be charged with liquidated damages or any excess cost when the delay in the completion of the Work is due to the following and the Contractor has promptly given written notice of such delay to the Owner (and Engineer if there is an Engineer on the Project):

A. To any preference, priority or allocation order duly issued by the Owner.

B. To unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not restricted to, acts of God or of the public enemy, acts of the Owner, acts of another contractor in the performance of a contract with the Owner, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and abnormal and unforeseeable weather; and,

C. To any delays of subcontractors occasioned by any of the causes specified in paragraphs A and B above.

16. Approval of Subcontractors. The Contractor acknowledges and agrees that any person, firm or other party to whom it is proposed to award a subcontract under this Contract must be approved in writing by the Owner prior to the subcontractor performing any work on the Project.

17. Entire Agreement. This Contract and the Contract Documents constitute the entire agreement between the parties hereto with respect to its subject matter and there are no representations, warranties, agreements, undertakings or conditions, express or implied, except as set forth herein. In the event of any conflict between the provisions of the Contract and the other Contract Documents, the provisions of the Contract control.

18. Modification to Agreement. This Contract may not be amended, supplemented or otherwise modified except by written instrument signed by each of the parties hereto.

19. Notices. Any notices or other communications required or permitted to be given and instruments referred to herein must be given in writing and personally delivered or mailed by prepaid certified mail to the following addresses:

If to Owner: Dalton Utilities
Attn: CEO
PO Box 869
1200 V.D. Parrott, Jr. Parkway
Dalton, Georgia 30722

If to Contractor:

Any such notice or other communication shall be deemed to have been given (whether actually received or not) on the day it is mailed (postmarked) or personally delivered as aforesaid. Any party may change its address for purposes of this Contract by giving notice of said change to the other parties pursuant to this Section.

20. Non-Waiver. No delay or failure by either party to exercise any right under this Contract, and no partial or single exercise of that right shall constitute a waiver of that or any other right, unless otherwise expressly provided herein.

21. Severability. Every provision of this Contract is intended to be severable, and, if any term or provision is determined to be illegal or invalid for any reason whatsoever, such illegality or invalidity shall not affect the validity of the remainder of this Contract.

22. Governing Law. This Contract shall be deemed to have entered into in and shall be construed in accordance with and governed by the laws of the State of Georgia.

23. Binding Effect. The provisions of this Contract shall be binding upon and shall insure to the benefit of each of the parties hereto and their respective and permitted successors and assigns.

24. Time is of the Essence. Time is of the essence of each and every provision of this Contract.

25. No Third-Party Beneficiaries. Except as may be otherwise expressly provided in this Contract, nothing contained herein, express or implied, is intended to, nor shall it (1) confer on any entity other than the parties hereto and their respective and permitted, successors and assigns, any rights, remedies, obligations under or by reason of this Contract.

26. Captions. The sections and captions contained herein are for convenience and reference only, and are not intended to define, extend, extend, or limit any provision of this Contract.

27. Confidentiality. To the extent not prohibited by law, the Contractor shall keep confidential the terms of the Contract Documents.

28. Assignment. This Contract may not be assigned by the Contractor without the prior written consent of the Owner.

29. No partnership. This Contract shall not be interpreted or construed to create an association, joint venture, partnership, or employer-employee relationship between the Parties, nor to impose any such obligations or liability on either party. Furthermore, neither party shall have any right, power, or authority to enter into any agreement or undertaking for or on behalf of, to act as, or be an agent or representative of, or to otherwise bind the other party.

30. Counterparts. This Contract may be executed in one or more counterparts, each of which shall be deemed an original, and all of which together shall constitute one and the same instrument.

IN WITNESS WHEREOF, the parties hereto have executed this Contract under their respective seals on the day and date first above written in four (4) counterparts, each of which shall without proof or accounting for the other counterparts be deemed an original Agreement.

ATTEST: (As to Contractor)

CONTRACTOR

(signed)

By: _____ L.S.

Printed: _____

Title: _____

(SEAL)

ATTEST:

BOARD OF WATER, LIGHT AND
SINKING FUND COMMISSIONERS
OF THE CITY OF DALTON, GEORGIA

Chief Watershed Services Officer

By: _____ L.S.

(SEAL)
Tom Bundros
CEO

Date: _____

STATE OF _____

COUNTY OF _____

In accordance with O.C.G.A. §36-91-21(e), we, the undersigned of

_____,
being first duly sworn, deposes and says that:

We have not directly or indirectly violated O.C.G.A. §36-91-21 (d), and more specifically, we have not

- prevented or attempted to prevent competition in such bidding or proposals by any means whatever,
- prevented or endeavored to prevent anyone from making a bid or proposal thereof by any means whatever, nor
- caused or induced another to withdraw a bid or proposal for the work.

We, the undersigned, to the best of our knowledge, affirm that no other officers, agents or other persons acted for or represented the Contractor in the bidding for and procurement of this Contract.

Signature	Printed Name	Title	Date
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

(Notary Public) My Commission Expires: _____

(SEAL)

END OF SECTION

Residency Status Affidavit

**Affidavit Verifying Residency Status of an Applicant as Required by
The Georgia Security and Immigration Compliance Act**

By executing this affidavit under oath, as an applicant for a Board of Water, Light and Sinking Fund Commissioners of the City of Dalton, Georgia D/B/A Dalton Utilities contract or other public benefit as referenced in the Georgia Security and Immigration Compliance Act (O.C.G.A. § 50-36-1), I am stating the following with respect to my application and award for a contract with the Board of Water, Light and Sinking Fund Commissioners of the City of Dalton, Georgia D/B/A Dalton Utilities.

_____ **I am a United States citizen**

OR

_____ **I am a legal permanent resident 18 years of age or older or I am an otherwise qualified alien or non-immigrant under the Federal Immigration and Nationality Act 18 years of age or older and lawfully present in the United States.***

Attach a copy of the document verifying your status (front and back) to this Affidavit.

In making the above representation under oath, I understand that any person who knowingly and willfully makes a false, fictitious, or fraudulent statement or representation in an affidavit shall be guilty of a violation of Code Section 16-10-20 of the Official Code of Georgia.

Signature of Applicant

Date

Printed Name

*Alien registration number for non-citizens

Applying on Behalf of/Name of Associated Business

SUBSCRIBED AND SWORN BEFORE ME ON THIS ____ DAY OF _____, 20__

Notary Public

My Commission Expires:

*Note: O.C.G.A. 50-36-1(e)(2) requires that aliens under the federal Immigration and nationality Act, Title 8 U.S.C., as amended, provide their alien registration number. Because legal permanent residents are included in the federal definition of "alien", legal permanent residents must also provide their alien registration number.

END OF SECTION

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, CONTRACTOR NAME AND ADDRESS (hereinafter called the "Principal") and **SURETY NAME AND ADDRESS** (hereinafter called the "Surety") are held and firmly bound unto The Board of Water, Light and Sinking Fund Commissioners of the City of Dalton, Georgia d/b/a Dalton Utilities (hereinafter called the "Owner") and its successors and assigns, in the penal sum of **CONTRACT AMOUNT** lawful money of the United States of America, for the payment of which the Principal and the Surety bind themselves, their administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered, or is about to enter, into a certain written contract with the Owner, dated _____, **202__** which is incorporated hereby by reference in its entirety (hereinafter called the "Construction Contract"), for the **LOOPERS WASTEWATER TREATMENT PLANT DEWATERING FACILITY UPGRADES**, more particularly described in the Construction Contract (hereinafter called the "Project"); and

NOW, THEREFORE, the conditions of this obligation are as follows, that if the Principal shall fully and completely perform all the undertakings, covenants, terms, conditions, warranties, and guarantees contained in the Construction Contract, including all modifications, amendments, changes, deletions, additions, and alterations thereto that may hereafter be made, then this obligation shall be void; otherwise, it shall remain in full force and effect.

Whenever the Principal shall be, and declared by the Owner to be, in default under the Construction Contract, the Surety shall promptly remedy the default as follows:

1. Complete the Construction Contract in accordance with the terms and conditions;
or

2. Obtain a bid or bids for completing the Construction Contract in accordance with its terms and conditions, and upon determination by the Surety and the Owner of the lowest responsible bidder, arrange for a contract between such bidder and Owner and make available as the work progresses (even though there should be a default or succession of defaults under the Construction Contract or contracts of completion arranged under this paragraph) sufficient funds to pay the cost of completion less the balance of the contract price; but not exceeding, including other costs and damages for which the Surety may be liable hereunder, the penal sum set forth in the first paragraph hereof, as may be adjusted, and the Surety shall make available and pay to the Owner the funds required by this Paragraph prior to the payment of the Owner of the balance of the contract price, or any portion thereof. The term "balance of the contract price," as used in this paragraph, shall mean the total amount payable by the Owner to the Contractor under the Construction Contract, and any amendments thereto, less the amount paid by the Owner to the Contractor; or, at the option of the Owner,

3. Allow Owner to complete the work and reimburse the Owner for all reasonable costs incurred in completing the work.

In addition to performing as required in the above paragraphs, the Surety shall indemnify and hold harmless the Owner from any and all losses, liability and damages, claims, judgments, liens, costs and fees of every description, including reasonable attorney's fees, litigation costs and expert witness fees, which the Owner may incur, sustain, or suffer by reason of the failure or default on the part of the Principal in the performance of any or all of the terms, provisions, and requirements of the Construction Contract, including any and all amendments and modifications thereto, or incurred by the Owner in making good any such failure of performance on the part of the Principal.

The Surety shall commence performance of its obligations and undertakings under this Bond promptly and without delay, after written notice from the Owner to Surety.

The Surety hereby waives notice of any and all modifications, omissions, additions, changes, alterations, extensions of time, changes in payment terms, and any other amendments in or about the Construction Contract, and agrees that the obligations undertaken by this bond shall not be impaired in any manner by reason of any such modifications, omissions, additions, changes, alterations, extensions of time, change in payment terms, and amendments.

The Surety hereby agrees that this Bond shall be deemed amended automatically and immediately, without formal or separate amendments hereto, upon any amendment to the Construction Contract, so as to bind the Principal and the Surety to the full and faithful performance of the Construction Contract as so amended or modified, and so as to increase the penal sum to the adjusted Contract Price of the Construction Contract.

No right of action shall accrue on this Bond to or for the use of any person, entity, or corporation other than the Owner and any other obligee named herein, or their executors, administrators, successors or assigns.

This Bond is intended to comply with O.C.G.A. Section 36-91-70, and shall be interpreted so as to comply with the minimum requirements thereof. However, in the event the express language of this Bond extends protection to the Owner beyond that contemplated by O.C.G.A. Section 36-91-70, or any other statutory law applicable to this Project, then the additional protection shall be enforced in favor of the Owner, whether or not such protection is found in the applicable statutes.

IN WITNESS WHEREOF, the undersigned have caused this instrument to be executed and their respective corporate seals to be affixed and attested by their duly authorized representatives this _____ day of _____, 202__.

CONTRACTOR:

By: _____
Title: _____

Attest:

Title: _____

(SEAL)

SURETY:

By: _____
Title: _____

By: _____
Title: _____

By: _____
Title: _____

Attest:

Title: _____

(SEAL)

[Attach Power of Attorney]

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, CONTRACTOR NAME AND ADDRESS (hereinafter called the "Principal") and **SURETY NAME AND ADDRESS** (hereinafter called the "Surety") are held and firmly bound unto The Board of Water, Light and Sinking Fund Commissioners of the City of Dalton, Georgia d/b/a Dalton Utilities (hereinafter called the "Owner") and its successors and assigns, in the penal sum of **CONTRACT AMOUNT**, lawful money of the United States of America, for the payment of which the Principal and the Surety bind themselves, their administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered, or is about to enter, into a certain written contract with the Owner, dated _____, **202**__ which is incorporated hereby by reference in its entirety (hereinafter called the "Construction Contract"), for the **LOOPERS WASTEWATER TREATMENT PLANT DEWATERING FACILITY UPGRADES**, more particularly described in the Construction Contract (hereinafter called the "Project"); and

NOW, THEREFORE, the condition of this obligation is such that if the Principal shall promptly make payment to all persons working on or supplying labor or materials under the Construction Contract, and any amendments thereto, with regard to labor or materials furnished and used in the Project, and with regard to labor or materials furnished but not so used, then this obligation shall be void; but otherwise it shall remain in full force and effect.

1. A "Claimant" shall be defined herein as any subcontractor, person, party, partnership, corporation or other entity furnishing labor, services, or materials used, or reasonably required for use, in the performance of the Construction Contract, without regard to whether such labor, services, or materials were sold, leased or rented, and without regard to whether such Claimant is or is not in privity of contract with the Principal or any subcontractor performing work on the Project, including, but not limited to, the following labor, services or materials: water, gas, power, light, heat, oil, gasoline, telephone service or rental of equipment directly applicable to the Construction Contract.

2. In the event a Claimant files a claim against the Owner, or the property of the Owner, and the Principal fails or refuses to satisfy or discharge it promptly, the Surety shall satisfy or discharge the claim promptly upon written notice from the Owner, either by bond or as otherwise provided in the Construction Contract.

3. The Surety hereby waives notice of any and all modifications, omissions, additions, changes, alterations, extensions of time, changes in payment terms, and any other amendments in or about the Construction Contract and agrees that the obligations undertaken by this Bond shall not be impaired in any manner by reason of any such modifications, omissions, additions, changes, alterations, extensions of time, changes in payment terms, and amendments.

4. The Surety hereby agrees that this Bond shall be deemed amended automatically and immediately, without formal or separate amendments hereto, upon any amendment or modification to the Construction Contract, so as to bind the Principal and Surety, jointly and severally, to the full payment of any Claimant under the Construction Contract, as amended or

modified, provided only that the Surety shall not be liable for more than the penal sum of the Bond, as specified in the first paragraph hereof.

5. This Bond is made for the use and benefit of all persons, firms and corporations who or which may furnish any materials or perform any labor for or on account of the construction to be performed or supplied under the Construction Contract, and any amendments thereto, and they and each of them may sue hereon.

6. No action may be maintained on this Bond after one (1) year from the date the last services, labor or materials were provided under the Construction Contract by the Claimant prosecuting said action.

7. This Bond is intended to comply with O.C.G.A. Section 36-91-90, and shall be interpreted so as to comply with the minimum requirements thereof. However, in the event the express language of this Bond extends protection to the Owner beyond that contemplated by O.C.G.A. Section 36-91-90, or any other statutory law applicable to this Project, then the additional protection shall be enforced in favor of the Owner, whether or not such protection is found in the applicable statutes.

IN WITNESS WHEREOF, the undersigned have caused this instrument to be executed and their respective corporate seals to be affixed and attested by their duly authorized representatives this _____ day of _____, 202__.

CONTRACTOR:

By: _____
Title: _____

Attest:

Title: _____

(SEAL)

SURETY:

By: _____
Title: _____

By: _____
Title: _____

By: _____
Title: _____

Attest:

Title: _____

(SEAL)

[Attach Power of Attorney]

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

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STANDARD GENERAL CONDITIONS OF THE
CONSTRUCTION CONTRACT

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
 2. *Agreement*—The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.
 3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. *Asbestos*—Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.
 5. *Bid*—The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 6. *Bidder*—The individual or entity who submits a Bid directly to Owner.
 7. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).
 8. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and the Bid Form with any supplements.
 9. *Change Order*—A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.
 10. *Claim*—A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.
 11. *Contract*—The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.
 12. *Contract Documents*—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop

Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

13. *Contract Price*—The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).
14. *Contract Times*—The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any; (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.
15. *Contractor*—The individual or entity with whom Owner has entered into the Agreement.
16. *Cost of the Work*—See Paragraph 11.01 for definition.
- 16.1 *Designer* - The individual or entity named as such in the Agreement, if a different person or entity from Engineer.
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. The term Drawings shall be considered synonymous with the term Plans.
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 01 of the Specifications. The General Requirements are applicable to all Sections of the Specifications and to the entire Work.
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.

25.1 Liquidated Damages – amounts shall be as stipulated in the Agreement. Liquidated damages shall apply to the Contract Times for the Project. Liquidated Damages shall be both additive and cumulative. Liquidated Damages shall end upon Substantial Completion, Completion of the Work associated with each Milestone Date, and upon final completion of the Work. Liquidated damages are not a penalty, but constitute liquidated damages for loss to the Owner because of increases in expenses for administration, legal counsel, accounting, engineering, construction supervision, inspection, and any other expenses incurred directly as a result of the delay of the Contractor in completing the work. This provision for liquidated damages shall be effective between the parties ipso facto without necessity for demand or putting in default by any notice or other means than by the terms of these Contract Documents, the Contractor hereby waiving any such other notice of default and acknowledging that the Contractor shall be deemed to be in default by the mere act of his failure to complete the work within the Contract Time, or within any valid extension of such time hereunder.

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. The Owner may designate an authorized representative to exercise the authority, in whole or in part, identified in these contract Documents, with such designation being identified in the Supplementary Conditions.
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~~ its 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, brochures, schedules, specified design related submittals, 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 that will be fabricated or installed. Shop drawings may also mean detail drawings, working drawings, construction drawings, and engineering data.
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 to provide the following: (i) the Owner full time, uninterrupted, continuous operation of the work; and (ii) all required functional, performance, and operational or startup testing has been successfully demonstrated for all components, devices, equipment, and systems to the satisfaction of the Engineer in accordance with the requirements of the Specifications; and (iii) all required inspections and other work necessary for the Engineer to certify "substantially complete" have been completed. ~~, 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.
- 44.1 *Submittals* – All administrative documents, Shop Drawings, Samples, product data, manufacturer's literature, quality control documents, design related documents, record documents, contract close-out documents, and/or any other specified document prepared or assembled by or for Contractor and submitted by Contractor to the Owner and/or Engineer.
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, materials, tools, equipment, incidentals, 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.

2. Where the word “similar” occurs in the Contract Document, it shall have a general meaning and not be interpreted as being identical, and all details shall be worked out in relation to their location and their connection with other parts of the Work.

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 Owner ~~either~~, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which Owner ~~either of them~~ or any additional insured may reasonably request) which Contractor ~~is~~ and Owner ~~respectively~~ are required to purchase and maintain in accordance with Article 5.

2.02 Copies of Documents

- A. Owner ~~shall will~~ furnish to Contractor up to ~~ten~~ four printed or hard copies of the Drawings and Project Manual Contract Documents and one counterpart of the executed Contract Agreement. 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~~ date established in the Notice to Proceed. A Notice to Proceed may be given at any time within ~~30~~ 60 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~~ may 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 Commencement of the Contract Time ~~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; which indicates each required Submittal and the dates for submitting, time for reviewing and processing each Submittal (periodic Submittals may be listed by a common monthly date); and
 3. a preliminary Schedule of Values for all of the Work in a format acceptable to the Engineer and in accordance with the requirements specified in the General Requirements. ~~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~~ Not more than ten days after the preconstruction conference, 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 as being the Contractor's schedule for the ~~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. The Progress Schedule may subsequently be adjusted in accordance with Paragraph 6.04 and applicable provisions of the General Requirements.
 - 2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals. The Schedule of Submittals may subsequently be adjusted in accordance with Paragraph 6.04 and applicable provisions of the General Requirements.
 - 3. Contractor's Schedule of Values will be acceptable to the Engineer as to form and substance if it is provided in accordance with the General Requirements. ~~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 individual components of 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.

- D. Each and every clause or other provision required by law to be inserted in these Contract Documents shall be deemed to be inserted herein, and they shall be read and enforced as though it were included herein, and if through mistake or otherwise, any such provision is not inserted, or if not correctly inserted, then upon the application of either party, the Contract Documents shall forthwith be amended to make such insertion.
- E. "Imperative" or "Command" type language is used in the Contract Documents. This command language refers to and is directed to the Contractor.
- F. Emphasis, such as italics, underlining, bold text or quotes, may have been used throughout the Contract Documents. Use of emphasis shall not change the meaning of the term emphasized.

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. All sections of governing standard specifications relating to measurement and payment shall not apply to the work specified herein.

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 or reasonably should have known 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).
2. In resolving inconsistencies within the Contract Documents, precedence shall be given in the following descending order:
 - a. Change Orders, with latest Change Order taking precedent over preceding Change Orders
 - b. Work Change Directives
 - c. Field Orders
 - d. Engineer's written interpretations and clarifications
 - e. Notice to Proceed
 - f. Addenda
 - g. Contract Agreement
 - h. Supplementary Conditions
 - i. General Conditions
 - j. Specifications
 - k. Drawings
 1. Schedules on Drawings
 2. Notes on Drawings

3. Details on Drawings

4. Large Scale Drawings

5. Small Scale Drawings

6. Dimensions given as Figures

7. Scaled Dimensions

I. Bidding Requirements

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; or
 - 2. ~~Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17.D.3); or~~
 - 23. 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.

3.07 Contract Times

- A. All Contract Times and time limits stated in the Contract Documents are of the essence of the Agreement.
- B. The Contractor shall proceed with the Work at a rate of progress which will ensure completion within the Contract Times.
- C. It is expressly understood and agreed by and between the Contractor and the Owner, that the Contract Times for the Work described herein are reasonable time, taking into consideration the average climatic and economic conditions, and other factors prevailing in the locality of the Work.
- D. If the Contractor shall fail to perform the Work required within the Contract Times, or extended Contract Times if authorized by Change Order, then the Contractor shall pay to the Owner the full amount of liquidated damages specified in the Contract Documents for each calendar day that the Contractor shall be in default after the Contract Times stipulated in the Contract Documents.

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 that have been utilized by the Engineer in preparing the Contract Documents; -and
2. those drawings ~~known to Owner~~ of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities that have been utilized by the Engineer in preparing the Contract Documents).

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

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

4.03 *Differing Subsurface or Physical Conditions*

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

1. is of such a nature as to establish that any "technical data" on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or
2. is of such a nature as to require a change in the Contract Documents; or
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such

condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

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

C. *Possible Price and Times Adjustments:*

1. The Contract Price or the Contract Times, or both, ~~will~~may 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 or should have known 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 Field Order, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment ~~shall~~may 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.

D. The dimensions and descriptions given on the Drawings for adjacent work by others, if any, (including any existing facilities or utilities previously constructed for Owner) are based on the design drawings and not as-built drawings. Prior to commencing the Work, the Contractor shall verify all as-built conditions and information whenever existing facilities or utilities may impact the Work. Failure of Contractor to so verify all as-built conditions prior to commencing the Work shall bar Contractor from later seeking additional compensation for conflicts with existing facilities or utilities.

E. Prior to the construction or installation of any proposed facility or pipeline, the Contractor shall expose all existing utilities true to their vertical and horizontal location, within the vicinity of the Work. In order to avoid conflicts between existing and proposed facilities or utilities, the Contractor shall either relocate the existing or proposed utility on a temporary or permanent

basis, or shall take whatever means necessary to protect the existing facilities or utilities during the installation of proposed utilities, as approved by the Engineer. No additional payment will be made for the relocation of existing utilities or for any work associated with the protection of existing facilities or utilities.

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.
- B. Engineer may check the lines, elevations, and reference marks set by Contractor, and Contractor shall correct any errors disclosed by such check. Such a check shall not be considered as approval of Contractor's work and shall not relieve Contractor of the responsibility for accurate construction of the entire Work. Contractor shall furnish personnel to assist Engineer in checking lines and grades.
- C. The Contractor shall review the Contract Documents and the Project site to determine the presence and location of any property or rights-of-way monuments or markers, and to assess the possibility of disruption to these monuments or markers. It will be the Contractor's responsibility to flag, erect guard post, or provide offset references for the protection or the re-monumentation of these property or rights-of-way monuments or markers. In the event these monuments or markers are covered over or disturbed, it will be the Contractor's responsibility to employ a surveyor licensed in the state of that the Project is located to re-establish those monuments or markers of property or rights-of-way, which were present prior to Work on the Project.
- D. It shall be the Contractor's responsibility to verify all reference points shown on the Contract Documents prior to beginning Work on the site. This verification shall be conducted by professionally qualified personnel in a manner which will verify the accuracy of the information shown in the Contract Documents. On projects which involve the connection to, or additions to existing structures, the elevations of these existing structures shall also be verified. Any findings which differ from those shown on the Contract Documents shall be submitted in writing to the Engineer for resolution.
- E. Additional surveys necessary for the construction staking shall be performed by the Contractor, the cost of which shall be incorporated into the appropriate items of Work. On projects in which payment is classified by depth of cut, the construction staking shall be performed in a manner that will allow for the determination of cut classification.

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 issue a Work Change Directive or Change Order as appropriate regarding said condition. ~~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~~ is made by the Owner 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 below in the Supplementary Conditions.~~
1. Surety shall be in good standing with the agency having jurisdiction over sureties and insurance companies for the state in which the Project is located.
 2. Surety and Insurers must have an A.M. Best Financial Strength Rating of A or higher, with a Financial Size Category of X or higher.
 3. The surety shall have an underwriting limitation in Circular 570 in excess of the Contract Amount.
 4. No surety will be accepted who is now in default or delinquent on any bond.

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. ~~Deleted. 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 therefrom¹ and for temporary measures taken by Owner to restore use; 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.

¹ C. Provide Owner's Protective Liability Insurance, which shall be issued in the name of the Owner for liability and property damage.

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~~Contractor shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof ¹ plus coverage for loss of use in the amount of \$10 million ~~(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 Paragraphs 5.04 and 5.06 by Contractor 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. ¹Owner 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~~Contractor 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 ¹ for those losses which are not insured ~~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.
- ¹C. 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 Contractor in accordance with this Article 5 on the basis of non-conformance it is not complying with the Contract Documents, the objecting party shall so~~ Owner will notify the other party Contractor in writing thereof within 10 days after receipt of the certificates (or other evidence requested) required by of the date of delivery of such certificate to Owner in accordance with Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided by Contractor as the other Owner 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 ~~chooses~~ 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, provide quality control, 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. Any method of work suggested by the Owner or Engineer, but not specified, shall be used at the risk and responsibility of the Contractor; and the Owner and Engineer will assume no responsibility therefore. 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. Contractor shall also designate, in writing, a representative, hereinafter referred to as Project Manager, assigned to the Project on a full-time basis during execution of the Work who shall have the authority to act on behalf of Contractor, including executing the orders or directions of the Engineer without delay. This Superintendent and/or Project Manager shall have full authority to promptly supply products, tools, plant equipment, and labor as may be required to diligently prosecute the Work. All communications given to or received from the Superintendent and/or the Project Manager shall be binding on Contractor.

- C. If at any time during the Project the Superintendent or Project Manager leaves the Project site while Work is in progress, Engineer shall be notified and provided with the name of Contractor's representative having responsible charge.
- D. Contractor shall also designate the person responsible for Contractor's quality control while Work is in progress. Engineer shall be notified in writing prior to any change in quality control representative assignment.
- E. Prior to the Commencement of the Contract Time, Contractor shall furnish to the Owner and Engineer the names, resumes, 24 hour contact information and other relevant information associated with the Project Manager and the Superintendent that are to be assigned to this project. The Project Manager and Superintendent must be acceptable to the Owner and Engineer.

6.02 *Labor; Working Hours*

- A. Contractor shall provide competent, *skilled*, 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. Contractor shall, upon demand from the Engineer, immediately remove any manager, superintendent, foreman or workman whom the Engineer or Owner may consider incompetent or undesirable.
- 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.
- C. Regular working hours may be Monday through Friday, excluding holidays, occurring between the hours of 7:00 AM and 7:00 PM, unless restricted otherwise. Contractor shall establish regular scheduled work times, e.g., four 10-hour days, five 8-hour days, or five 10-hour days within the hours and days allowed above. Approval for specific work outside regular scheduled work times shall be requested no less than 48 hours prior to the requested work period. Contractor shall request approval of changes in regular scheduled work times no less than one week prior to the desired change. Occasional unscheduled overtime on weekdays may be permitted provided reasonable notice is given to Engineer. Night work will not be established as a regular procedure, excluding emergencies, except with written permission. Such permission, if granted, shall be upon such terms and conditions deemed appropriate in the Engineer's sole discretion.
- D. Contractor shall pay all extra costs incurred by the Owner associated with work, outside of normal working hours, including additional support services, inspection services, testing services, utilities or other applicable costs. The cost associated with the Owner's inspection overtime will be the amounts as provided in the Supplementary Conditions per hour per individual, depending upon individuals assigned to the Project, the type of work being inspected, and the date of the invoice; i.e., allowing for salary escalation. Contractor will not be responsible for extra costs associated with inspection overtime for work in excess of 40 hours per week when such overtime work is explicitly required by the Contract Documents.
- E. Except in the case of emergencies or other unusual circumstances, no work shall be permitted on the project on Sunday.

- F. The Engineer will determine to what extent extraordinary onsite personnel work is required during Contractor's overtime work or working hours outside regular scheduled work hours.
- G. During unfavorable weather, wet ground, or other unsuitable construction conditions, the Contractor shall confine his operations to work which will not be affected adversely thereby. No portion of the work shall be constructed under conditions which would affect adversely the quality or efficiency thereof, unless special means or precautions are taken by the Contractor to perform the work in a proper and satisfactory manner.

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, quality control, testing, start-up, and completion of the Work.
- B. All materials and equipment incorporated into the Work shall be as specified ~~or, and if not specified,~~ shall be of good quality, and new and unused, except as otherwise provided in the Contract Documents and shall be installed in an undamaged condition. All products provided on this Project shall be products currently manufactured by the manufacturer, i.e., products shall not be discontinued or out-of-date products nor shall they be of the last production run of the product. Contractor shall incorporate the previous sentence in any contract or agreement between Contractor and subcontractor or supplier supplying products provided on this Project. All special warranties and guarantees required by the ~~Specifications~~ Contract Documents 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.
- D. Without limiting the responsibility or liability of the Contractor pursuant to this agreement, all warranties given by manufacturers on materials or equipment incorporated in the work are hereby assigned by the Contractor to the Owner. Such assignment shall be effective upon completion of Contractor's warranty period. If requested, the Contractor shall execute formal assignments of said manufacturer's warranties to the Owner. All such warranties shall be directly enforceable by the Owner. Such assignment shall in no way affect the Contractor's responsibilities and duties during the warranty period.
- E. Wherever a stock size of manufactured item or piece of equipment is specified by its nominal size, it shall be the responsibility of the Contractor to determine the actual space requirements for setting and for entrance to the setting space and to make all necessary allowances and adjustments therefor in his work without additional cost to the Owner.
- F. Equipment and Construction Plant. All equipment and construction plant shall be suitable to produce the quality of work and materials required for the satisfactory completion of the work within the Contract Time and shall be satisfactory to the Engineer. The Contractor shall provide adequate and suitable equipment and construction plant to meet the requirements of the work as specified in these Contract Documents. The Contractor shall remove unsuitable equipment from the site of the work when ordered to do so by the Engineer. The Contractor shall obtain

written permission from the Owner prior to constructing temporary buildings or other structures on land owned or leased by the Owner. If permission is granted, said buildings or other structures shall comply with all applicable regulations regarding their construction and maintenance and shall be satisfactory to the Owner.

6.04 Progress Schedule

- A. Contractor shall provide all resources, labor, materials, equipment, services, etc. necessary to adhere to the Progress Schedule established in accordance with Paragraph 2.07 and the General Requirements 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 and the General Requirements) an updated the Progress Schedule that will not result in changing the Contract Times and an updated Schedule of Submittals with each partial payment request, but no less than monthly. Contractor's failure to provide acceptable updated Progress Schedule and Schedule of Submittals will delay processing of the pay request until receipt of the acceptable updated Progress Schedule and/or an updated Schedule of Submittals. Such adjustments will updates and adjustments shall 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.
 3. Number of anticipated days associated with weather conditions, as defined in the General Requirements, shall be included on the critical path of Project Schedule.
- B. The Contractor shall implement the detailed schedule of activities to the fullest extent possible between Project Coordination Meetings.
- C. The Contractor shall prepare its daily report by 10:00 a.m. of the day following the report date. This daily report will contain, as a minimum, the weather conditions; number of workers by craft, including supervision and management personnel on site; active and inactive equipment on site; work accomplished by schedule activity item; problems; and visitors to the jobsite.
- D. If a current activity or series of activities on the overall project schedule is behind schedule and if the late status is not due to an excusable delay for which a time extension would be forthcoming, the Contractor shall attempt to reschedule the activity to be consistent with the overall Project schedule so as not to delay any of the Contract milestones. The Contractor agrees that:
1. The Contractor shall attempt to expedite the activity completion so as to have it agree with the overall progress schedule. Such measures as the Contractor may choose shall be made explicit during the Project Coordination Meeting.
 2. If, within two weeks of identification of such behind-schedule activity, the Contractor is not successful in restoring the activity to an on schedule status, the Contractor shall:
 - a. Carry out the activity with the scheduled crew on an overtime basis until the activity is complete or back on schedule.
 - b. Increase the crew size or add shifts so the activity can be completed as scheduled.

c. Commit to overtime or increased crew sizes for subsequent activities, or some combination of the above as deemed suitable by the Engineer.

3. These actions shall be taken at no increase in the Contract amount.

E. The Contractor shall maintain a current copy of all construction schedules on prominent display in the Contractor's field office at the Project site.

F. The Contractor shall cooperate with the Owner and Engineer in all aspects of the Project scheduling system. Failure to implement the Project scheduling system or to provide specified schedules, diagrams and reports, or to implement actions to re-establish progress consistent with the overall progress schedule may be causes for withholding of payment.

G. If the Progress Schedule reflects a completion date prior to the completion date established by the Agreement, this shall afford no basis to claim for delay should Contractor not complete the Work prior to the projected completion date. Instead, all "float" between the completion date in Contractor's schedule and the completion date established in the Agreement shall belong to and is available to the Contractor and the Owner.

6.05 *Substitutes and "Or-Equals"*

~~A. See General Requirements. 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. Acceptance of any Subcontractor, other person or organization by Owner shall not constitute a waiver of any right of Owner to reject defective Work. Contractor shall not be required to employ any Subcontractor, 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. Such arrangement shall not operate to make the Engineer or the Owner an arbitrator to establish subcontract limits between Contractor and Subcontractor.
- G. All Work performed for Contractor by a Subcontractor or Supplier ~~will~~ shall 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.~~
- H. Owner or Engineer may furnish to any Subcontractor, Supplier or other person or organization, to the extent practicable, information about amounts paid on their behalf to Contractor in accordance with Contractor's Applications for Payment.
- I. Specialty Subcontractors: Contractor shall utilize the services of Specialty Subcontractors on those parts of the Work which is declared as specialty work in Specifications and which, under normal contracting practices, is best performed by Specialty Subcontractors, as required by the Engineer in Engineer's sole discretion, at no additional cost to the Owner. If Contractor desires

to self-perform specialty work, Contractor shall submit a request to the Owner, accompanied by evidence that Contractor's own organization has successfully performed the type of work in question, is presently competent to perform the type of work, and the performance of the work by Specialty Subcontractors will result in materially increased costs or inordinate delays.

J. The Contractor shall perform a minimum of 20 percent of the onsite labor with its own employees.

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~~ temporary permits and licenses, necessary and incidental to the due and lawful prosecution of the work, including all permits on any part of the Work as required by law in connection with the Work. Owner ~~shall~~ will assist Contractor, when required by the permitting agency 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, or both. 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.
- D. It is understood and agreed that the Contractor shall be familiar with and shall observe and comply with, all Federal, State, County, and local laws, codes, ordinances, regulations, orders, and decrees, including air and water pollution and noise abatement regulations, existing, or enacted subsequent to the execution of the Contract, that in any manner affect those engaged or employed in the work, or the materials or equipment used in the work, or which in any way affect the conduct of the work. The Contractor shall strictly observe all applicable laws and regulations as to public safety, health and sanitation. No pleas of misunderstanding or ignorance on the part of the Contractor will in any way serve to modify or mitigate the provisions of these Contract Documents. The Contractor and his Surety shall indemnify and save harmless the Owner and the Engineer and all their officers, agents, and servants against any claim or liability arising from, or based on the violation of, any such law, code, ordinance, regulation, order or decree, whether by himself, his agents or his employees.
- F. Where professional engineering and/or architectural services are required in connection with any of the components required by the Contract, all Bidders and component suppliers must make certain that there is full compliance with all applicable laws of the state in which the Project is located and any other state governing professional engineering and/or architecture. The Owner and Engineer do not warrant that any entity listed as an acceptable manufacturer is or will be in compliance with such laws.
- G. Any fines levied against the Owner for failure of Contractor to properly maintain required NPDES erosion and sediment control measures or any other related requirements will be deducted as set-offs from payments due Contractor.

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 Record Documents as specified in the General Requirements ~~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~~ shall 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 pollution of or 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).
- G. The property, improvements or facilities at the site shall be replaced or restored to a condition as good as when Contractor entered upon the Site. In case of failure on the part of Contractor to restore such property, or make good such damages or injury, the Owner may, after 48 hours

written notice, or sooner in the case of an emergency, proceed to repair, rebuild, or otherwise restore such property, improvements or facilities as may be deemed necessary. The cost thereof will be deducted from any monies due or which may become due Contractor under this Contract.

H. Reasonable care shall be taken during construction to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.

I. The Contractor shall give due notice to any controlling person, department, or public service company, prior to adjusting items to grade and shall be held strictly liable to the Owner if any such items are disturbed, damaged or covered up during the course of the work.

J. Fire hydrants on or adjacent to the work shall be kept accessible to the fire-fighting apparatus at all times, and no material or obstruction shall be placed within 10 feet of any hydrant. Adjacent premises must be given access, as far as practicable, and obstruction of sewer inlets, gutters and ditches will not be permitted.

K. Public Safety and Convenience

1. The Contractor shall conduct his operations in a manner that will offer the least possible obstruction and inconvenience to the public and he shall not have under construction an amount of work greater than he can prosecute properly with due regard to the rights of the public.

2. Construction operations shall be conducted in a manner that will cause as little inconvenience as possible to abutting property owners. Convenient access to driveways, houses, buildings or other facilities in the vicinity of the work shall be maintained and temporary access facilities for public roadways shall be provided and maintained in satisfactory condition.

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.

B. The Contractor shall erect and properly maintain at all times, as required by the conditions and progress of the work, all necessary safeguards, including sufficient lights and danger signals on or near the work; it shall erect suitable railings, barricades, covers, or other protective devices about unfinished work, open trenches, holes, embankments or other hazards and obstructions; where hazards to workmen or the public exist. The Contractor shall provide, at all times, all necessary watchmen on the project, for the safety of employees, delivery personnel, and the

general public, and to diligently guard and protect all work and materials, including Owner-furnished equipment. Construction equipment shall be suitably night-marked and lighted as necessary for safety considerations.

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~~ and Other Submittals*

- A. Contractor shall submit ~~Shop Drawings and Samples~~ Submittals to Engineer for review and approval in accordance with the accepted or adjusted Schedule of Submittals (as required by Paragraph 2.07). Each submittal ~~will~~ shall 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~~ shall 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~~ any Submittal 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 Shop Drawing and Sample 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 return as incomplete or will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval or disapproval 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 or disapproval 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~~Field Order 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.
4. Review by the Owner or Engineer of any plan or method of work proposed by the Contractor shall not relieve the Contractor of any responsibility therefor, and such review shall not be considered as an assumption of any risk or liability by the Owner or Engineer, or any officer, agent, or employee thereof. The Contractor shall have no claim on account of the failure or inefficiency of any plan or method so reviewed.

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.

F. Excessive Submittal Resubmission: Engineer will record time required by Engineer for excessive Submittal review occasioned by Contractor's resubmission, in excess of two resubmissions of any required Submittal, caused by unverified, unchecked or unreviewed, incomplete, inaccurate or erroneous, or nonconforming Submittals. Upon receipt of Engineer's accounting of time and costs, Contractor will reimburse Owner for the charges of Engineer's review for excessive resubmissions through set-offs from the recommended Owner payments to Contractor as established in Paragraph 14.02.D. of these General Conditions.

G. In the event that Contractor provided a submittal for a previously approved item, whether such is as a substitution or in addition to the previously approved item, Contractor shall reimburse Owner for Engineer's charges for such time as may be required to perform all reviews of the substitute item, unless the change is specifically requested by the Owner.

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 s~~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 and Liability

- A. It is understood and agreed that the Contractor shall be deemed and considered an independent contractor in respect to the work covered by these Contract Documents, and shall assume all risks and responsibility for casualties of every description in connection with the work, except that he shall not be held liable or responsible for delays or damage to work caused by acts of God, acts of public enemy, quarantine restrictions, general strikes throughout the trade, or freight embargoes not caused or participated in by the Contractor. The Contractor shall have charge and control of the entire work until completion and final acceptance of the work by the Owner. 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, regardless of whether or not caused in part by any negligence or omission of a person or entity indemnified hereunder or whether liability is imposed upon such indemnified party by Laws and Regulations regardless of the negligence of any such person or entity .
- 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 negligent preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

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

D. Contractor, Subcontractors, Suppliers and others on the Project, or their sureties, shall maintain no direct action against the Engineer, their officers, employees, affiliated corporations, consultants, 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 the Engineer.

E. Defense of Suits: In case any action in court is brought against the Owner or the Engineer, or any officer, agent or employee of any of them, for the failure, omission, or neglect of the Contractor to perform any of the covenants, acts, matters, or things by this contract undertaken; or for injury or damage caused by the alleged negligence of the Contractor or his subcontractors or his or their agents, or in connection with any claim based on lawful demands of subcontractors, workmen, material-men, or suppliers, the Contractor shall indemnify, defend and save harmless the Owner and the Engineer and their officers, agents and employees, from all losses, damages, costs, expenses (including attorneys' fees), judgments, or decrees arising out of such action.

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.

6.22 Project Coordination Meetings

- A. The Contractor shall participate in Project Coordination Meetings to be held on the site monthly, or more often if conditions warrant, to establish the current state of completion and revise the schedule as necessary. The Project Coordination Meeting will be conducted by the Owner and/or the Engineer.

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 or both 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~~ contracts 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 with other contractors.

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.

7.04 Claims Between Contractors

- A. Should Contractor cause damage to the work or property of any separate contractor at the site, or should any claim arising out of Contractor's performance of the work at the site be made by any separate contractor against Contractor, Owner, Engineer, or any other person, Contractor shall promptly attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by mediation, arbitration, or at law.
- B. Contractor shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold Owner, Engineer, and the officers, directors, employees, agents, and other consultants of each and any of them harmless 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 directly, indirectly or consequentially out of or resulting from any action, legal or equitable, brought by any separate contractor against Owner, Engineer, or the officers, directors, employees, agents, and other consultants of each and any of them to the extent based on a claim arising out of Contractor's performance of the Work. Should a separate contractor cause damage to the Work or property of Contractor or should the performance of work by any separate contractor at the site give rise to any other claim, Contractor shall not institute any action, legal or equitable, against Owner, Engineer, or the officers, directors, employees, agents, and other consultants of each and any of them 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 mediator or arbitrator which seeks to impose liability on or to recover damages from Owner, Engineer, or the officers, directors, employees, agents, or other consultants of each and any of them on account of any such damage or claim.
- C. If Contractor is delayed at any time in performing or furnishing Work by any act or neglect of a separate contractor, and Owner and Contractor are unable to agree as to the extent of any adjustment in Contract Times attributable hereto, 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, and/or Engineer and the officers, directors, employees, agents, or other consultants of each and any of them for any delay, disruption, interference or hindrance caused by any separate contractor. This Paragraph does not prevent

recovery from Owner, Engineer, and/or Designer for activities that are their respective responsibilities.

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 shall not have any 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, but will not be on-site at all hours the Work is in progress. 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 therefore 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 have authority to determine the actual quantities and classifications of Unit Price Work performed by Contractor. If Engineer exercises such authority, 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 initial 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, except that Owner shall determine whether bonds, certificates of insurance and release of liens comply 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).
1. Owner may, in anticipation of possibly ordering an addition, deletion or revision to the Work, request Contractor to prepare a proposal of cost and times to perform Owner's contemplated changes in the Work. Contractor's written proposal shall be transmitted to the Engineer promptly, but not later than fourteen days after Contractor's receipt of Owner's written request and shall remain a firm offer for a period not less than sixty days after receipt by Engineer.
 2. Contractor is not authorized to proceed on an Owner contemplated change in the Work prior to Contractor's receipt of a Change Order (or Work Change Directive) incorporating such change into the Work.
 3. 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 Time (or Milestones).
 4. The Owner shall not be liable to the Contractor for any costs associated with the preparation of proposal associated with the Owner's contemplated changes in the Work.
- 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.

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

1. The stipulated compensation (Contract Price or Contract Time, or both) set forth in the Change Order includes payment for:
 - a. the Cost of the Work covered by the Change Order,
 - b. Contractor's fee for overhead and profit,
 - c. interruption of Progress Schedules,
 - d. delay and impact, including cumulative impact, on other work under the Contract Documents, and
 - e. extended home office and jobsite overhead;
2. the Change Order constitutes full mutual accord and satisfaction for the change to the Work;
3. No reservation of rights to pursue subsequent claims on the Change Order will be made by either party; and

4. No subsequent claim or amendment of the Contract Documents will arise out of or as a result of the Change Order.

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 and Disputes*

- A. *Engineer's Decision Required:* All Claims and disputes, 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~~ 10 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 written supporting data shall be delivered to the Engineer and the other party to the Contract within ~~60-20~~ days (and monthly thereafter for continuing events) 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.

1. Full rental cost for rented, leased, and/or owned equipment shall not exceed the rates listed in the Rental Rate Blue Book published by Equipment Watch, a unit of Penton Media, Inc., as adjusted to the regional area of the Project. The most recent published edition in effect at the commencement of the 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. Equipment in Use: Actual equipment use time documented by the Engineer shall be the basis that the 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 operating cost, payment category (and the table below), and associated rate set forth in the Blue Book if not already included in the lease rate.

The hours of operation shall be based upon actual equipment usage to the nearest full hour, as recorded by the Engineer.

<u>Actual Usage</u>	<u>Blue Book Payment Category</u>
<u>Less than 8 hours</u>	<u>Hourly Rate</u>
<u>8 or more hours but less than 7 days</u>	<u>Daily Rate</u>
<u>7 or more days but less than 30 days</u>	<u>Weekly Rate</u>
<u>30 days or more</u>	<u>Monthly Rate</u>

4. Equipment when idle (Standby): Idle or standby equipment is equipment on-site 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 the Engineer, shall be paid at the leasing rate determined in 11.01.A.5.c., excluding operational costs.

5. Where a breakdown occurs on any piece of equipment, payment shall cease for that equipment and any other equipment idled by the breakdown. If any part of the Work is shutdown by the Owner, standby time will be paid during non-operating 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.

- 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 any of the Work that has been completed and accepted by the Owner, 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. If, however, any such loss or damage to the Work that has been accepted by Owner requires reconstruction and Contractor is placed in charge thereof, Contractor shall be paid for services, a fee proportionate to that stated in Paragraph 12.01.C.
- 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 value or unit price values (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 or unit price 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 based on subcontractor's actual Cost of the Work;
 - 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; except the maximum total allowable cost to Owner shall be the Cost of the Work plus a maximum collective aggregate fee for Contractor and all tiered Subcontractors of 26.8 percent.
 - 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~~may 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, quarantine restrictions, strikes, freight embargoes, acts of war (declared or not declared), 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~~ may be entitled to an equitable adjustment in Contract Times, but not Contract Price, 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.
- F. If the Progress Schedule reflects a completion date or milestone date prior to the completion date or milestone date established by the Contract Documents, this shall afford no basis to claim for delay should Contractor not complete the Work prior to the projected completion date. Should a change order be executed with a revised completion date or milestone date, the Progress Schedule shall be revised to reflect the new completion date or milestone date.

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 is responsible for the initial and subsequent inspections of Contractor's Work to ensure that the Work conforms to the requirements of the Contract Documents. 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. Contractor shall establish an inspection program and a testing plan acceptable to the Engineer and shall maintain complete inspection and testing records available to Engineer.
- B. Owner shall employ and pay for the services of an independent testing laboratory to perform all non-contractor 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.
- G. Tests required by Contract Documents to be performed by Contractor and that require test certificates to 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:

1. "Recommended Requirements for Independent Laboratory Qualification", published by the American Council of Independent Laboratories.
2. Basic requirements of ASTM E329, "Standard of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction" as applicable.
3. Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.

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.
- B. If Owner stops Work under Paragraph 13.05.A. Contractor shall not be entitled to an extension of Contract Time or increase in Contract Price.

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.
- C. Contractor shall promptly segregate and remove rejected products from the Site.
- D. If rejected products or Work is not removed within 48 hours, as provided in Paragraph 13.05 above, the Owner will have the right and authority to stop the Work immediately and will have the right to arrange for the removal of said rejected products or Work at the cost and expense of the Contractor.

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, and all to the satisfaction of the Owner:
 - 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~~shall 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.
- F. Repetitive malfunction of an equipment or product item shall be cause for replacement and an extension of the correction period to a date one year following acceptable replacement. A repetitive malfunction shall be defined as the third failure of an equipment or product item following original acceptance.

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~~shall be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

- A. If Contractor fails within a reasonable time, as defined by the Engineer, 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 and as modified 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 five copies of 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. Retainage:
 - a. _____ The amount of retainage with respect to progress payments will be as stipulated in the Agreement.
 - b. _____ No form of collateral in lieu of cash will be acceptable as retainage.

- c. Amounts retained by the Contractor from payments due to suppliers and subcontractors (expressed as a percentage) shall not exceed that being retained by the Owner.

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~~ 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.

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; if any.

4. Items entitling Owner to retain set-offs from the amount recommended, include but are not limited to:

- a. Owner compensation to Engineer at an estimated average rate as specified in the Supplementary Conditions per each extra personnel hour for labor plus expenses because of the following Contractor-caused events:

- (1) Witnessing retesting of corrected or replaced defective Work;

- (2) Return visits to manufacturing facilities to witness factory testing or retesting;

- (3) Submittal reviews in excess of three reviews by Engineer for substantially the same Submittal;

- (4) Evaluation of proposed substitutes and in making changes to Contract Documents occasioned thereby;

- (5) Hours worked by Contractor, in excess of normal work hours as defined by Article 6.02 of the General Conditions, necessitating Engineer to work overtime;

- (6) Return visits to the Project by Engineer for Commissioning Activities not performed on the initial visit;

- b. Fines levied against the Owner for Contractor's performance of NPDES Erosion and Sedimentation Control Measures or other permit violations.

- c. The repair, rebuilding or restoration of property improvements or facilities by the Owner as outlined in Paragraph 6.13.

- d. Liability for liquidated damages incurred by Contractor as set forth 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, retainage notwithstanding, free and clear of all Liens.
- B. No materials or supplies for the Work shall be purchased by Contractor or subcontractor subject to any chattel mortgage or under a conditional sale contract or other agreement by which an

interest is retained by the seller. Contractor warrants that Contractor has good title to all materials and supplies used by Contractor in the Work, free from all liens, claims or encumbrances.

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. Specific items of Work that must be completed prior to the Engineer's issuance of a certificate of Substantial Completion include, but are not limited to, the following:
1. Correction of all deficient Work items listed by all state, local, and other regulatory agencies or departments.
 2. All submittals must be received and approved by the Engineer, including but not necessarily limited to, the following:
 - a. Record documents.
 - b. Factory test reports, where required.
 - c. Equipment and structure test reports.
 - d. Manufacturer's Certificate of Proper Installation.
 - e. Operating and maintenance information, instructions, manuals, documents, drawings, diagrams, and records.
 - f. Spare parts lists.
 3. All additional warranty or insurance coverage requirements have been provided.
 4. All manufacturer/vendor-provided operator training is complete and documented.
 5. Other items of Work specified elsewhere as being prerequisite for 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-direct~~ Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to ~~be ready for~~ sufficiently progressed towards 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 described in Paragraph 14.05.A.1 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. Under no circumstances will Contractor's application for final payment be accepted by the Engineer until all Work required by the Contract Documents has been completed.
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, if requested by the Engineer;
 - c. a list of all Claims against Owner that Contractor believes are unsettled;
 - d. an affidavit that all payrolls, bills for materials and equipment, and other indebtedness connected with the Work have been paid or otherwise satisfied;
 - e. the final Change Order signed by the Contractor to close the Contract; and
 - f. 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, if requested by the Engineer.
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 all 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~~ Thereupon 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. If the Application for Payment and accompanying documentation are appropriate as to form and substance, Owner will in accordance with the applicable State or local General Law, pay Contractor the amount recommended by Engineer.

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~~ may 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;
 5. If Contractor abandons the Work, or sublets this Contract or any part thereof, without the previous written consent of Owner, or if the Contract or any claim thereunder shall be assigned by Contractor otherwise than as herein specified;
 6. Contractor is adjudged bankrupt or insolvent;
 7. Contractor makes a general assignment for the benefit of creditors;
 8. A trustee or receiver is appointed for Contractor or for any of Contractor's property;
 9. Contractor files a petition to take advantage of any debtor's relief act, or to reorganize under the bankruptcy or applicable laws;
 10. Contractor repeatedly fails to supply sufficient skilled workmen, materials or equipment;
 11. Contractor fails to make satisfactory progress toward timely completion of the work; or
 12. Contractor repeatedly fails to make prompt payments to subcontractors or material suppliers for labor, materials or equipment.
- 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, unless Contractor otherwise cures the deficiency in accordance with Paragraph 15.02.D.:
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 or discontinue, in whole or in part, 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. direct 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; and-
 5. ten percent overhead and profit for those costs agreed to in Paragraphs 15.03.A.1 through 15.03.A.4 above.
- B. Contractor shall submit within 30 calendar days after receipt of notice of termination a written statement setting forth its proposal for an adjustment to the Contract Price to include only the incurred costs described in this clause. Owner shall review, analyze, and verify such proposal and negotiate an equitable amount and the Contract may be modified accordingly.
- C. 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.
- C. Except as allowed in Paragraph A above, the Contractor shall not suspend the work and shall not remove any equipment, tools, supplies, materials, or other items without the written permission of the Owner.

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, or by facsimile transmission and followed by written confirmation, to the last business address known to the giver of the notice.
- B. All notices required of Contractor shall be performed in writing to the appropriate entity.
- C. Electronic mail and messages will not be recognized as a written notice.
- D. If the Contractor does not notify the Owner in accordance with Paragraph 10.05 of the belief that a field order, work by other contractors or the Owner, or subsurface, latent, or unusual unknown conditions entitles the Contractor to a Change Order, no consideration for time or money will be given the Contractor.

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.

17.07 *Addresses*

- A. Both the address given in the Bid form upon which this Agreement is founded, and Contractor's office at or near the site of the Work are hereby designated as places to either of which notices, letters, and other communications to Contractor shall be certified, mailed, or delivered. The delivering at the above named place, or depositing in a postpaid wrapper directed to the first-named place, in any post office box regularly maintained by the post office department, of any notice, letter or other communication to Contractor shall be deemed sufficient service thereof upon date of such delivery or mailing. The first-named address may be changed at any time by an instrument in writing, executed by Contractor, and delivered to and acknowledged by the Owner and Engineer. Nothing herein contained shall be deemed to preclude or render inoperative the service of any notice, letter, or other communication upon Contractor personally.

17.08 *Forms and Record*

- A. The form of all Submittals, notices, change orders and other documents permitted or required to be used or transmitted under the Contract Documents shall be determined by the Engineer.
- B. Contractor shall maintain throughout the term of the Contract, complete and accurate records of all Contractor's costs which relate to the work performed, including the extra work, under the terms of the Contract. The Owner, or its authorized representative, shall have the right at any reasonable time to examine and audit the original records.
- C. Records to be maintained and retained by Contractor shall include, but not be limited to:

1. Payroll records accounting for total time distribution of Contractor's employees working full or part time on the work;
 2. Cancelled payroll checks or signed receipts for payroll payments in cash;
 3. Invoices for purchases, receiving and issuing documents, and all other unit inventory records for Contractor's stores, stock, or capital items;
 4. Paid invoices and cancelled checks for materials purchase, subcontractors, and any other third parties' charges;
 5. Original estimate and change order estimate files and detailed worksheets;
 6. All project-related correspondence; and
 7. Subcontractor and supplier change order files (including detailed documentation covering negotiated settlements).
- D. Owner shall also have the right to audit: any other supporting evidence necessary to substantiate charges related to this agreement (both direct and indirect costs, including overhead allocations as they may apply to costs associated with this agreement); and any records necessary to permit evaluation and verification of Contractor compliance with contract requirements and compliance with provisions for pricing change orders, payments, or claims submitted by Contractor or any payees thereof. Contractor shall also be required to include the right to audit provision in the contracts (including those of a lump-sum nature) of all subcontractors, insurance agents, or any other business entity providing goods and services.

17.09 Assignment

- A. Contractor shall not assign, sell, transfer or otherwise dispose of the whole or any part of this Contract or any monies due or to become due hereunder without written consent of the Owner. In case Contractor assigns all or any part of any monies due or to become due under this Contract, the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of the assignee in and to any monies due or to become due to Contractor shall be subject to prior liens of all persons, firms and corporations for services rendered or materials supplied for the performance of the Work called for under this Contract.

17.10 Inspection by Public Agencies

- A. Authorized representatives of the federal, state, local and other governmental agencies having jurisdiction over the work or any part thereof shall have access to the work and any records relevant to the prosecution and progress of the work. The Contractor shall provide proper facilities for such access and inspection.

END OF SECTION

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, EJCDC C-700 (2007 Edition, with Dalton Utilities Modifications 05/11/19). All provisions which 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.

The provisions in this Section of the Specifications shall govern in the event of any conflict between this Section and the General Conditions.

SC-4.02 *Subsurface and Physical Conditions*

SC-4.02 Add the following new paragraphs immediately after Paragraph 4.02.B:

C. The following reports of explorations and tests of subsurface conditions at or contiguous to the Site have been used by the Engineer in preparing the Contract Documents:

1. Not used.

D. The following drawings of physical conditions relating to existing surface or subsurface structures at the Site have been used by the Engineer in preparing the Contract Documents:

1. Dalton Utilities Sludge Processing Facility dated June 22, 1999 and prepared by Jennings – King Architects, Inc.

None of the information in such drawings constitutes "technical data" on which Contractor may rely.

SC-4.06 *Hazardous Environmental Conditions*

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

A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner.

B. Not Used.

SC-5.03 *Certificates of Insurance*

SC-5.03, following Paragraph E, add the following,

F. Copies of endorsements showing that each additional insured identified herein have been added to the policies as an additional insured shall be attached to each of the certificates.

- G. Each insurance certificate for all coverages other than Worker's Compensation Insurance must show that a waiver of rights of recovery against any of the insured or the additional insured is in effect.
- H. Certificate for Worker's Compensation and Employer's Liability coverage must indicate inclusion or exclusion for any proprietor, partner, executive officer or member.

SC-5.04 *Contractor's Insurance*

SC-5.04.B.1 CornerStone Design Services, LLC.

SC-5.04.C, following Paragraph 5.04.B.6.b, Add,

- C. The limits of liability for the insurance required by paragraph 5.04.B.2 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:
 - 1. Worker's compensation, disability benefits and other similar employee benefit acts, and damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees as provided in Paragraphs 5.04.A.1 and 5.04.A.2 of the General Conditions:
 - a. Workers Compensation: Statutory limits
 - b. Employer's Liability, Each Accident: \$2,000,000
 - c. Employer's Liability, Each Employee: \$1,000,000
 - d. Employer's Liability, Disease – Policy Limit: \$1,000,000
 - 2. Contractor's General Liability Insurance under paragraphs 5.04.A.3 through 5.04.A.5 of the General Conditions shall provide the following minimum limits and conditions:
 - a. Each Occurrence: \$2,000,000.
 - b. Damage to Rented Premises (each occurrence) \$100,000.
 - c. Medical Expenses (any one person) \$5,000.
 - d. Personal and Advertising Injury: \$1,000,000.
 - e. General Aggregate: \$2,000,000.
 - f. Products-Completed Operations Aggregate: \$2,000,000.
 - g. Explosion, collapse, and underground coverage shall be included with such indicated on the insurance certificate under General Liability.
 - h. The general aggregate policy limits must be designated to the Project.

- i. Contractual Liability coverage, as required under Paragraph 5.04.B.3 must be indicated on the insurance certificate under General Liability.
3. Automobile Liability under Paragraph 5.04.A.6 of the General Conditions, providing for Combined Single Limit (each accident) for all owned, hired, and non-owned vehicles: \$1,000,000.
4. Provide Excess Liability or Umbrella Liability insurance providing protection for at least the hazards insured under the primary liability policies with the following limits:
 - a. General Aggregate: \$10,000,000.
 - b. Each Occurrence: \$10,000,000.
5. Owner's Protective Liability: The Contractor shall procure and shall maintain during the life of the Contract Agreement, Owner's Protective Liability Insurance with the same limits as the Comprehensive General Liability.

SC-6.02 *Labor; Working Hours*

SC-6.02 Add the following subparagraph 6.02.D.1:

1. The following rates will apply for the overtime work on behalf of the Owner: \$100.00/hour to \$135.00/hour, depending on actual Resident Project Representative assigned to the Project.

SC-6.08 *Permits*

SC-6.08 Add the following subparagraphs 6.08.B.1:

1. The Owner will provide the following Permits:
 - a. Georgia Environmental Protection Division for modifications to water treatment plant.

SC-6.09 *Laws and Regulations*

SC-6.09 Add the following subparagraph 6.08.H:

- H. Contractor shall perform those duties as they relate to O.C.G.A. Section 36-91-92 and O.C.G.A. Section 44-14-361.5, including filing the Notice of Commencement. Contractor shall provide Owner and Engineer with proof of having performed these duties before any progress payments or final payment shall be considered due and payable to the Contractor.

SC-6.10 *Taxes*

SC-6.10 Add the following subparagraph 6.10.B:

- H. The Contractor shall provide a written tabulation, plus other documentation as may be required, of all taxes, including sales tax, paid by the Contractor to assist the Owner in obtaining sales and/or use tax refunds for eligible machinery and equipment used to condition air or water as provided for in O.C.G.A. Section 48-8-3.2(e)(8). Such written tabulation shall be included with each partial payment request. Additionally, the tabulation shall be documented with copies of invoices indicating the amount of tax paid, with all blanks completed on the invoice, and with a description of the function of the item included in the tabulation. All taxes will be paid by the Contractor. All refunds will accrue to the Owner.

SC-6.13 *Safety and Protection*

- SC-6.13 The Owner's safety plan that is applicable to the Work can be found at the offices of the Owner.

SC-6.17 *Shop Drawings, Samples and Other Submittals*

SC-6.17.D.4, first sentence,

Change, "... of any plan or method of work proposed by the Contractor ..."
to

"... of any calculations, plan or method of work, including any safety plans and quality plans, proposed by the Contractor ..."

SC-6.17.D.4, second sentence,

Change, "... any plan or method so reviewed."
to

"... any calculations, plan or method so reviewed."

SC-9.03 *Project Representative*

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

- B. The Resident Project Representative (RPR) will be Engineer's employee or agent at the Site, will act as directed by and under the supervision of Engineer, and will confer with Engineer regarding RPR's actions. RPR's dealings in matters pertaining to the Work in general shall be with Engineer and Contractor. RPR's dealings with Subcontractors shall be only through or with the full knowledge and approval of Contractor. The RPR shall:
1. *Schedules:* Review the progress schedule, schedule of Shop Drawing and Sample submittals, and schedule of values prepared by Contractor and consult with Engineer concerning acceptability.
 2. *Conferences and Meetings:* Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences and other project-related meetings, and prepare and circulate copies of minutes thereof.
 3. *Liaison:*

- a. Serve as Engineer's liaison with Contractor, working principally through Contractor's authorized representative, assist in providing information regarding the intent of the Contract Documents.
 - b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.
 - c. Assist in obtaining from Owner additional details or information, when required for proper execution of the Work.
4. *Interpretation of Contract Documents:* Report to Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.
5. *Shop Drawings and Samples:*
 - a. Record date of receipt of Samples and approved Shop Drawings.
 - b. Receive Samples which are furnished at the Site by Contractor, and notify Engineer of availability of Samples for examination.
6. *Modifications:* Consider and evaluate Contractor's suggestions for modifications in Drawings or Specifications and report such suggestions, together with RPR's recommendations, to Engineer. Transmit to Contractor in writing decisions as issued by Engineer.
7. *Review of Work and Rejection of Defective Work:*
 - a. Conduct on-Site observations of Contractor's work in progress to assist Engineer in determining if the Work is in general proceeding in accordance with the Contract Documents.
 - b. Report to Engineer whenever RPR believes that any part of Contractor's work in progress 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 work in progress that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.
8. *Inspections, Tests, and System Startups:*
 - a. Verify that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate Owner's personnel, and that Contractor maintains adequate records thereof.

- b. Observe, record, and report to Engineer appropriate details relative to the test procedures and systems start-ups.

9. *Records:*

- a. Record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of all Contractors, Subcontractors, and major Suppliers of materials and equipment.
- b. Maintain records for use in preparing Project documentation.

10. *Reports:*

- a. Furnish to Engineer periodic reports as required of progress of the Work and of Contractor's compliance with the progress schedule and schedule of Shop Drawing and Sample submittals.
- b. Draft and recommend to Engineer proposed Change Orders, Work Change Directives, and Field Orders. Obtain backup material from Contractor.
- c. Immediately notify Engineer of the occurrence of any 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.

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.

12. *Certificates, Operation and Maintenance Manuals:* During the course of the Work, verify that materials and equipment certificates, operation and maintenance manuals and other data required by the 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 delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

13. *Completion:*

- a. Participate in a Substantial Completion inspection, assist in the determination of Substantial Completion and the preparation of lists of items to be completed or corrected.
- b. 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.

- c. Observe whether all items on the final list have been completed or corrected and make recommendations to Engineer concerning acceptance and issuance of the Notice of Acceptability of the Work.

C. The RPR shall not:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).
2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.
3. Undertake any of the responsibilities of Contractor, Subcontractors, Suppliers, or Contractor's superintendent.
4. Advise on, issue directions relative to, or assume control over any 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.
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.
6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.
7. Accept Shop Drawing or Sample submittals from anyone other than Contractor.
8. Authorize Owner to occupy the Project in whole or in part.

SC-13.06.A

Change, "Promptly after receipt of written notice, Contractor shall correct all defective Work, ..." to
 "The Contractor shall respond to the Engineer and Owner within three (3) business days after receipt of written notice of the defective work from the Engineer or Owner. The Contractor shall correct all defective work in a timely manner, ..."

SC-13.07.A

Change, "... Contractor shall promptly, without cost ..." to
 "... Contractor shall respond to the Engineer and Owner within three (3) business days after receipt of written notice from the Engineer or Owner of defective work or defective repairs of damages to lands or areas made available to Contractor, and shall promptly, without cost ..."

SC-14.02.D.4.a(5) Delete Paragraph (5) in its entirety and replace with the following:

(5) Deleted

SC-14.02.D.4.e After paragraph 14.02.D. 4.d, add the following:

5. The following rates will be for the additional services performed by the Engineer on behalf of the Owner: \$75.00/hour to \$250.00/hour, depending upon staff level person involved.

SC-14.02.E After paragraph 14.02.D, add the following:

E. Prompt Payment Clause

1. Owner and Contractor agree that all partial payments and final payments shall be subject to the Georgia Prompt Pay Act, as originally enacted and amended, and as set forth in O.C.G.A. 13-11-1 through 13-11-11, except as provided below to the extent authorized by law.
2. Interest Rate: For purposes of computing interest on late payments, the rate of interest shall be one-half percent per month or a pro-rata fraction thereof on the unpaid balance as may be due.
3. Payment Periods:
 - a. When Contractor has performed in accordance with the provisions of these Contract Documents, the Owner shall pay Contractor within 30 days of receipt by the Owner or the Owner's representative of any properly completed Application for Payment, based upon work completed or service provided pursuant to the terms of these Contract Documents.
 - b. When a subcontractor has performed in accordance with the provisions of its subcontract and the subcontract conditions precedent to payment have been satisfied, Contractor shall pay to that subcontractor and each subcontractor shall pay to its subcontractor, within ten days of receipt by Contractor or subcontractor of each periodic or final payment, the full amount received for such subcontractors work and materials based on work completed or service provided under the subcontract, less retainage expressed as a percentage, but such retainage shall not exceed that retainage being held by the Owner, provided that the subcontractor has provided or provides such satisfactory reasonable assurances of continued performance and financial responsibility to complete its work as contractor in its reasonable discretion may require, including but not limited to a payment and performance bond.
4. Interest on Late Payment: Except otherwise provided in these Contract Documents and/or in O.C.G.A. 13-11-5, if a periodic or final payment to Contractor is delayed by more than the time allotted in Paragraph 14.02.E.3b, or if a periodic or final payment to a subcontractor is delayed more than ten days after receipt of periodic or final payment by Contractor or Subcontractor, the Owner, Contractor, or subcontractor, as the case may be, shall pay interest to its Contractor, or subcontractor beginning on the day following the due dates as

provided in Paragraph 14.02.E.3b, at the rate of interest as provided herein. Interest shall be computed per month or a pro-rata fraction thereof on the unpaid balance. There shall be no compounded interest. No interest is due unless the person or entity being charged interest received "Notice" as provided in Paragraph 14.02.E.5. Acceptance or progress payments or final payment shall release all claims for interest on said payments.

5. Notice of Late Payment and Request of Interest: Any person or entity asserting entitlement to interest on any periodic or final payment pursuant to the provisions of this Prompt Payment Clause shall provide "notice" to the person or entity being charged interest of the charging party's claim to interest on late payment. "Notice" shall be in writing, served by U.S. Certified Mail – Return Receipt Requested at the time the properly completed Application for Payment is received by the Owner or Owner's representative, and shall set forth the following:
 - a. A short and concise statement that interest is due pursuant to the provisions of the Georgia Prompt Pay Act and this Prompt Payment Clause;
 - b. The principal amount of the periodic or final payment which is allegedly due to the charging party; and
 - c. The first day and date upon which the charging party alleges that said interest will begin to accrue, pursuant to the provisions of the Georgia Prompt Pay Act and this Prompt Payment Clause.
6. These "Notice" provisions are of the essence; therefore, failure to comply with any requirement as set forth in the Prompt Payment Clause precludes the right to interest on any alleged late payment to which said "Notice" would otherwise apply.
7. Integration with the Georgia Prompt Pay Act: Unless otherwise provided in these Contract Documents, the parties hereto agree that these provisions of this Prompt Payment Clause supersede and control all provisions of the Georgia Prompt Pay Act (O.C.G.A. 13-11-1 through 13-11-11), as originally enacted and as amended, and that any dispute arising between the parties hereto as to whether or not the provisions of this contract or the Georgia Prompt Pay Act control will be resolved in favor of these Contract Documents and its terms.

SC-17.05 After paragraph 17.05.A, add the following:

- B. The parties acknowledge that this Contract is executed in Whitfield County, Georgia and that the Contract is to be performed in Whitfield County, Georgia. Each party hereby consents to the Whitfield County Superior Court's sole jurisdiction over any dispute which arises as a result of the execution or performance of this Agreement, and each party hereby waives any and all objections to venue in the Whitfield County Superior Court.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Work by Contractor.
- B. Contractor Use of Site and Premises.
- C. Partial Owner Occupancy.
- D. Quantities.

1.2 Work by Contractor

- A. The work to be performed under this Contract shall consist of furnishing all labor, materials, tools, equipment and incidentals and performing all work required to construct complete in place and ready to operate the improvements shown in the Contract Documents. These improvements include, but are not limited to, the following:
 - 1. Replacing two existing centrifuges with two Flottweg Model C5E centrifuges including miscellaneous piping and appurtenances.
 - 2. Constructing sludge conveyor improvements including replacing the vertical conveyor with an inclined conveyor section, new loading station, and rehabilitation of the existing conveyor system.
 - 3. Constructing polymer system improvements including two new polymer blending units.
 - 4. Performing building improvements, including
 - a. Replacement of all HVAC systems, structural modifications.
 - b. Repainting of the entire building
 - c. Miscellaneous corroded metal repair.
 - d. Replacing all electrical switchgear, panels and distribution wiring systems.
 - 5. Improvements to the SCADA and instrumentation systems.

- B. The Contractor shall be responsible for providing all labor, equipment and materials to complete this Project. The Contractor shall provide its own generators or make arrangements for temporary power.
- C. The Contractor shall be responsible for the cost of permits or licenses required to complete the work. The Contractor shall complete all necessary clean-up and restoration work such that post construction conditions are equal to or better than those conditions that existed prior to any construction activity occurring.
- D. The Owner is authorized to issue change orders, without the necessity of additional requests for bids, within the scope of the Project when appropriate or necessary in the performance of the contract. No additional work shall be performed unless authorized by the Owner.
- E. All work described above shall be performed as shown on the Drawings and as specified.
- F. Project Location
 - 1. The equipment and materials to be furnished will be installed at the locations shown on the Drawings.

1.3 Contractor Use of Site and Premises

- A. See Section 01 35 00.

1.4 Partial Owner Occupancy

- A. The Owner will occupy existing facilities to which these improvements are being made and will continue operation during the period of construction.
- B. There shall not be any interruption in service. The Contractor is responsible for fines assessed due to his activities.
- C. Whenever, in the opinion of the Engineer, any section or portion of the work or any structure is in suitable condition, it may be put into use upon the written order of the Engineer and such usage will not be held in any way as an acceptance of said work or structure, or any part thereof, or as a waiver of any of the provisions of these Specifications and the Contract. Pending final completion and acceptance of the Work, all necessary repairs and replacements, due to defective materials or workmanship or operations of the Contractor, for any section of the work so put into use shall be performed by the Contractor at Contractor's own expense.

1.5 Quantities

- A. The Owner reserves the right to alter the quantities of work to be performed or to extend or shorten the improvements at any time when and as found necessary, and the Contractor shall perform the work as altered, increased or decreased. Payment for such increased or decreased quantity will be made in accordance with the Instructions to Bidders. No allowance will be made for any change in anticipated profits nor shall such changes be considered as waiving or invalidating any conditions or provisions of the Contract and Bond.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Equipment Allowances – Non-Dewatering Equipment**Part 1 General****1.1 Scope**

- A. The Contractor shall furnish and install the equipment identified in the Equipment Allowances. Equipment identified in the Equipment Allowances shall be subject to all provisions of these Specifications.
- B. In the event of failure of manufacture to perform, whether Goods, Special Services or schedule for such, the Contractor's sole remedy shall be against the manufacture under the terms and conditions of its procurement agreement with the manufacturer. The Owner and Engineer do not warrant the performance of the manufacturer.
- C. The terms and conditions of the Schneider Electric Systems USA, Inc. and SPIRAC (USA) INC. proposals contained in the Equipment Allowance Scope of Work of these Specifications shall be considered subject to negotiations between the successful Bidder and the Seller of the products.

1.2 Costs

- A. The Contractor shall include, in the Bid Total, the Equipment Allowances specified in the Bid for the purchase of equipment which has been pre-selected by the Owner. These allowances shall cover the cost of the equipment and services, as specified in the indicated Specification Sections, and Freight-on-Board (FOB) Job Site.
- B. The Contractor's applicable taxes, unloading, storage, handling, labor, installation, and overhead costs, plus profit and other expenses contemplated for the allowances shall be included in Item 1 of the Bid and not in the allowances.
- C. If the terms and conditions of purchase of equipment and services differ from those given in these Contract Documents, then the Contractor shall include the cost of the differences in Item 1 of the Bid.

1.3 Adjustment of Costs

- A. Should the final invoice amount from the equipment manufacturer be more or less than the specified amount of the allowance, the Contract will be adjusted by a change order. Such adjustment shall be limited to the cost directly attributable to changes authorized by the Engineer and Owner for a change in scope only.
- B. The amount of change order will not recognize any changes in unloading, storage, handling, labor, installation, and overhead costs, nor profit and other expenses caused by the adjustment of the final invoice amount. The change order will recognize changes in applicable taxes.

1.4 Documentation

- A. Submit copies of new invoices from the equipment manufacturer with each periodic payment request.

1.5 Schedule of Equipment Allowances

- A. Instrumentation and SCADA System: Allow the amount specified in the Bid for equipment and services indicated in the Schneider Electric Systems USA, Inc. proposal contained in Equipment Allowance Scope of Work included with the Contract Documents.
- B. Shaftless Screw Conveyors: Allow the amount specified in the Bid for equipment and services indicated in the SPIRAC (USA) INC. proposal contained in Equipment Allowance Scope of Work included with the Contract Documents.

END OF SECTION

Equipment Allowances – Dewatering Equipment**Part 1 General****1.1 Scope**

- A. The Contractor shall furnish and install the equipment identified in the Equipment Allowances. Equipment identified in the Equipment Allowances shall be subject to all provisions of these Specifications.
- B. The Contractor, as Buyer, and the manufacturer, as Seller, shall both be bound by to the scope of work for Goods and Special Services, schedules for performance, and the terms and conditions for the amounts included in the document entitled "Equipment Allowance Scope of Work".
- C. The Owner, Contractor and Seller shall execute, without further negotiation, the Assignment of Procurement Agreement contained in the "Equipment Allowance Scope of Work" within 30 days after Owner's Notice to Proceed to the Contractor.
- D. In the event of failure of manufacturer to perform, whether Goods, Special Services or schedule for such, the Contractor's sole remedy shall be against the manufacturer under the terms and conditions of its procurement agreement with the manufacturer. The Owner and Engineer do not warrant the performance of the manufacturer.

1.2 Costs

- A. The Contractor shall include, in the Bid Total, the Equipment Allowances specified in the Bid for the purchase of equipment which has been pre-selected by the Owner. These allowances shall cover the cost of the equipment and services, as specified in the indicated Specification Sections, and Freight-on-Board (FOB) Job Site.
- B. The Contractor's applicable taxes, including but not limited to sales tax, unloading, storage, handling, labor, installation, and overhead costs, plus profit and other expenses contemplated for the allowances shall be included in Item 1 of the Bid and not in the allowances.
- C. If the terms of and conditions of purchase of equipment and services differ from those given in these Contract Documents, then the Contractor shall include the cost of the differences in Item 1 of the Bid.

1.3 Adjustment of Costs

- A. Should the final invoice amount from the equipment manufacturer be more or less than the specified amount of the allowance, the Contract will be adjusted by a change order. Such adjustment shall be limited to the cost directly attributable to changes authorized by the Engineer and Owner for a change in scope, schedule or terms and conditions.
- B. The amount of change order will not recognize any changes in unloading, storage, handling, labor, installation, and overhead costs, nor profit and other expenses caused

by the adjustment of the final invoice amount. The change order will recognize changes in applicable taxes.

1.4 Documentation

- A. Submit copies of new invoices from the equipment manufacturer with each periodic payment request.

1.5 Schedule of Equipment Allowances

- A. Dewatering Equipment: Allow the amount specified in the Bid for the dewatering equipment and services provided by Flottweg Separation Technology, Inc. as included in the Equipment Allowance Scope of Work included with these Contract Documents.

END OF SECTION

Part 1 General

1.1 Scope

- A. The Bid lists each item of the Project for which payment will be made. No payment will be made for any items other than those listed in the Bid.
- B. Required items of work and incidentals necessary for the satisfactory completion of the work which are not specifically listed in the Bid, and which are not specified in this section to be measured or to be included in one of the items listed in the Bid, shall be considered as incidental to the work. All costs thereof, including Contractor's overhead costs and profit, shall be considered as included in the lump sum or unit prices bid for the various Bid items. The Contractor shall prepare the Bid accordingly.
- C. Work includes furnishing all plant, labor, equipment, tools and materials, which are not furnished by the Owner and performing all operations required to complete the work satisfactorily, in place, as specified and as indicated on the Drawings.

1.2 Descriptions

- A. Measurement of an item of work will be by the unit indicated in the Bid.
- B. Final payment quantities shall be determined from the record drawings. The record drawing lengths, dimensions, quantities, etc. shall be determined by a survey after the completion of all required work. The precision of final payment quantities shall match the precision shown for that item in the Bid.
- C. Payment will include all necessary and incidental related work not specified to be included in any other item of work listed in the Bid.
- D. Unless otherwise stated in individual sections of the Specifications or in the Bid, no separate payment will be made for any item of work, materials, parts, equipment, supplies or related items required to perform and complete the work. The costs for all such items required shall be included in the price bid for item of which it is a part.
- E. Payment will be made by extending unit prices multiplied by quantities provided and then summing the extended prices to reflect actual work. Such price and payment shall constitute full compensation to the Contractor for furnishing all plant, labor, equipment, tools and materials not furnished by the Owner and for performing all operations required to provide to the Owner the entire Project, complete in place, as specified and as indicated on the Drawings.

1.3 Cash Allowances

- A. General
 - 1. The Contractor shall include in the Bid Total all allowances stated in the Contract Documents. These allowances shall cover the net cost of the services provided by a firm selected by the Owner. The Contractor's handling costs, labor,

Measurement and Payment

overhead, profit and other expenses contemplated for the original allowance shall be included in the items to which they pertain and not in allowances.

2. No payment will be made for nonproductive time on the part of testing personnel due to the Contractor's failure to properly coordinate testing activities with the work schedule or the Contractor's problems with maintaining equipment in good working condition.
 3. No payment shall be provided for services which fail to verify required results.
- B. Should the net cost be more or less than the specified amount of the allowance, the Contract will be adjusted accordingly by change order. The amount of change order will not recognize any changes in handling costs at the site, labor, overhead, profit and other expenses caused by the adjustment to the allowance.
- C. Documentation
1. Submit copies of the invoices with each periodic payment request from the firm providing the services.
 2. Submit results of services provided which verify required results.
- D. Schedule of Cash Allowances
1. Materials Testing: Allow the amount provided in the Bid for the services of a testing firm and testing laboratory for the testing of concrete cylinders for poured in place concrete, and other materials testing as required by the Engineer.

1.4 Owner's Contingency Allowance

- A. Allow the amount provided in the Bid for the use of unexpected matters deemed necessary and approved by the Owner. Such allowance may be used to compensate Contractor monies that otherwise may be due Contractor in lieu of execution of a Change Order.

1.5 Erosion and Sedimentation Control

- A. General
1. No separate payment shall be made for temporary and/or permanent erosion and sedimentation controls. All temporary and/or permanent erosion and sedimentation control costs shall be included in the unit price bid for the item to which it pertains.
 2. No payment will be made for any portion of the Project for which temporary erosion and sedimentation controls are not properly maintained.

1.6 Earthwork

A. Site Preparation

1. No separate payment will be made for site preparation or restoration work.

1.7 Site Utilities

- A. Solid sleeves and fittings necessary for connections to existing site utilities, even if not shown on the Drawings, are considered incidental to the Project and will not be paid for separately. Additionally, no payment will be made for fittings provided due to the Contractor's sequence of construction, layout problems, tie-ins or repairs.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. This section outlines the restrictions and requirements for substitutions, product and manufacturer options, and construction method options.

1.2 Definitions

- A. For the purposes of these Contract Documents, a “substitute item” shall be defined as one of the following:
 - 1. A product or manufacturer offered as a replacement to a specified product or manufacturer.
 - 2. A product or manufacturer offered in addition to a specified product or manufacturer.
- B. For the purposes of these Contract Documents, a “substitute construction method” shall be defined as one of the following:
 - 1. A mean, method, technique, sequence or procedure of construction offered as a replacement for a specified mean, method, technique, sequence or procedure of construction.
 - 2. A mean, method, technique, sequence or procedure of construction offered in addition to a specified mean, method, technique, sequence or procedure of construction.

1.3 General

- A. An item or construction method, which is offered where no specific product, manufacturer, mean, method, technique, sequence or procedure of construction is specified or shown on the Drawings, shall not be considered a substitute and shall be at the option of the Contractor, subject to the provisions in the Contract Documents for that item or construction method.
- B. For products specified only by a referenced standard, the Contractor may select any product by any manufacturer, which meets the requirements of the Specifications, unless indicated otherwise in the Contract Documents.
- C. If the manufacturer is named on the Drawings or in the Specifications as an acceptable manufacturer, products of that manufacturer meeting all requirements of the Specifications and Drawings are acceptable.
- D. Whenever the Engineer's design is based on a specific product of a particular manufacturer, that manufacturer will be shown on the Drawings and/or listed first in the list of approved manufacturers in the Specifications. Any Bidder intending to furnish products of other than the first listed manufacturer, or furnish substitute items, shall:

Substitution Procedures

1. Verify that the item being furnished will fit in the space allowed, perform the same functions and have the same capabilities as the item specified,
2. Include in its Bid the cost of all accessory items which may be required by the other listed substitute product,
3. Include the cost of any architectural, structural, mechanical, piping, electrical or other modifications required, and
4. Include the cost of required additional work by the Engineer, if any, to accommodate the item.

1.4 Approvals

- A. Approval, of a substitution as an acceptable manufacturer, of the Engineer is dependent on determination that the product offered is essentially equal in function, performance, quality of manufacture, ease of maintenance, reliability, service life and other criteria to that on which the design is based; and will require no major modifications to structures, electrical systems, control systems or piping systems.

1.5 Substitutions and Options

- A. After Notice to Proceed
 1. Substitute items will be considered only if the term "equal to" precedes the names of acceptable manufacturers in the Specification.
 2. Where items are specified by referenced standard or specified as indicated in Article 1.3, Paragraph B above, such items shall be submitted to the Engineer for review.
 3. The Contractor shall submit shop drawings on the substitute item for the Engineer's review in accordance with Section 01 33 00.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. The work under this Section includes preparation and submittal of a schedule of values.

1.2 General

- A. Timing of Submittal: Submit to the Engineer, a schedule of values allocated to the various portions of the work, within 10 days after Notice to Proceed. The first progress payment will not be made until the next pay cycle following the Engineer's approval of the Contractor's values.
- B. Supporting Data: Upon request of the Engineer, support the values with data which will substantiate their correctness.
- C. Use of Schedule: The schedule of values, unless objected to by the Engineer, shall be used only as a basis of the Contractor's Application for Payment.

1.3 Form and Content of Schedule of Values

- A. Form and Identification
 - 1. Type schedule on 8-1/2 x 11-inch white paper.
 - 2. Contractor's standard forms and automated printout may be used.
 - 3. Identify schedule with:
 - a. Title of Project and location.
 - b. Engineer.
 - c. Name and address of Contractor.
 - d. Contract designation.
 - e. Date of submission.
- B. Schedule shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction. Breakdown shall be by structure, then by CSI Format, for ease of field verification of quantities completed in each structure.

C. Format

1. Follow the Table of Contents of the Contract Documents as the format for listing the component items.
2. Identify each item with the number and title of the respective major section of the Specifications.

D. For each major line item list sub-values of major products or operations under the item.

E. For the Various Portions of the Work:

1. Each item shall include a directly proportional amount of the Contractor's overhead and profit.
2. For items on which progress payments will be requested for stored materials, break down the value into:
 - a. The cost of the materials, delivered and unloaded, with taxes paid.
 - b. The total installed value, including Contractor's overhead and profit, less item a. above.

F. The sum of all values listed in the schedule shall equal the Bid Total.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. Work under this Section includes all scheduling and administering of pre-construction and progress meetings as herein specified and necessary for the proper and complete performance of this work.
- B. Scheduling and Administration by Engineer:
 - 1. Prepare agenda.
 - 2. Make physical arrangements for the meetings.
 - 3. Preside at meetings.
 - 4. Record minutes and include significant proceedings and decisions.
 - 5. Distribute copies of the minutes to participants.

1.2 Preconstruction Conference

- A. The Engineer shall schedule the preconstruction conference prior to the issuance of the Notice to Proceed.
- B. Representatives of the following parties are to be in attendance at the meeting:
 - 1. Owner.
 - 2. Engineer.
 - 3. Contractor and superintendent.
 - 4. Major subcontractors.
 - 5. Representatives of governmental or regulatory agencies when appropriate.
- C. The agenda for the preconstruction conference shall consist of the following as a minimum:
 - 1. Distribute and discuss a list of major subcontractors and a tentative construction schedule.
 - 2. Critical work sequencing.
 - 3. Designation of responsible personnel and emergency telephone numbers.
 - 4. Processing of field decisions and change orders.

5. Adequacy of distribution of Contract Documents.
6. Schedule and submittal of shop drawings, product data and samples.
7. Pay request format, submittal cutoff date, pay date and retainage.
8. Procedures for maintaining record documents.
9. Use of premises, including office and storage areas and Owner's requirements.
10. Major equipment deliveries and priorities.
11. Safety and first aid procedures.
12. Security procedures.
13. Housekeeping procedures.
14. Work hours.

1.3 Project Coordination Meetings

- A. Attend regular monthly meetings as directed by the Engineer.
- B. Hold called meetings as the progress of the work dictates.
- C. The meetings shall be held at the location indicated by the Engineer.
- D. Representatives of the following parties are to be in attendance at the meetings:
 1. Engineer.
 2. Contractor and superintendent.
 3. Major subcontractors as pertinent to the agenda.
 4. Owner's representative as appropriate.
 5. Representatives of governmental or other regulatory agencies as appropriate.
- E. The minimum agenda for progress meetings shall consist of the following:
 1. Review and approve minutes of previous meetings.
 2. Review work progress since last meeting.
 3. Note field observations, problems and decisions.

4. Identify problems which impede planned progress.
5. Review off-site fabrication problems.
6. Review Contractor's corrective measures and procedures to regain plan schedule.
7. Review Contractor's revision to the construction schedule as outlined in the Supplementary Conditions.
8. Review submittal schedule; expedite as required to maintain schedule.
9. Maintenance of quality and work standards.
10. Review changes proposed by Owner for their effect on the construction schedule and completion date.
11. Complete other current business.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. The work under this Section includes, but is not necessarily limited to, the preparation, furnishing, distribution, and periodic revision of construction schedules as herein specified and as necessary for the proper and complete performance of this work.

1.2 Quality Assurance

- A. Oracle Primavera Project Management or Microsoft Project for Critical Path Method (CPM) scheduling, shall be used to develop the Project schedules.

1.3 Submittals

- A. Preliminary Project Schedule (PPS)
 - 1. Submit the PPS within 30 days after the effective date of the Contract Agreement.
 - 2. The Engineer will review schedule and will return the reviewed copy within 15 days after receipt.
 - 3. If required, resubmit, incorporating all revisions, within five days after receipt of a returned review copy.
- B. Schedule of Values (SOV)
 - 1. Submit the SOV within 10 days after the date of the Notice to Proceed.
 - 2. The Engineer will review the SOV and return a reviewed copy within 15 days after receipt.
 - 3. If required, resubmit, incorporating all revisions, within five days after receipt of a returned review copy.
- C. Overall Project Schedule (OPS)
 - 1. Submit the schedule within 60 days after date of the Notice to Proceed.
 - 2. The Engineer will review the OPS and return it within 20 days after receipt.
 - 3. If required, resubmit, incorporating all revisions, within ten days after receipt of a returned copy.
 - 4. Failure of the Contractor to meet the schedule submission milestones will result in withholding of monthly payments until deliverables associated with

the milestones are received. Payments will be withheld should the Contractor fail to deliver an acceptable schedule within 90 days after date of the Notice to Proceed.

D. Near Term Schedule (NTS)

1. Submit the first NTS within 10 days of the Notice to Proceed.
2. The Engineer will review the NTS and return it within 10 days after receipt.

E. Facility Shutdowns

1. As part of the Project Schedules, include all anticipated facility shutdowns, including but not limited to the following:
 - a. Temporary relocations.
 - b. Temporary bypasses.
 - c. Transitions from existing to temporary, temporary to new, and the like.
2. For each anticipated shutdown included in the schedule, submit within 90 days of Notice to Proceed, a description of the shutdown, extent, anticipated start date, anticipated duration or completion date, related preparation work, and related temporary facilities to be provided.

F. Updating: Submit a monthly update of the OPS and NTS with each request for payment. Provide each update on a CD (provide two copies) along with hard copies printed in color (one - 11 x 17 and one – 22 x 34). Include with the monthly update a complete report indicating all comparisons between the previous schedule and the current update as well as a narrative description of the changes made.

G. Consultant: Submit the name and qualifications of the scheduling consultant or in-house resource including a list of similar projects where the scheduling experience was gained.

1.4 Initial Development and Review

- A. Prior to development of the schedule, the Contractor and approved scheduling consultant/in-house resource shall meet with the Engineer to discuss and agree on how activity codes will be set up, activity identification, and the basic structure of the schedule.
- B. Acceptance of the Contractor's PPS, SOV, OPS, and NTS and revisions thereto, shall in no way relieve the Contractor of any duties and obligations under the Contract. Such approval is limited to the format of the schedule and does not in any way indicate approval of, or concurrence with, the Contractor's means, methods, and ability to carry out the Work.

Part 2 Products

2.1 Preliminary Project Schedule (PPS)

- A. The Preliminary Project Schedule shall be a bar chart or time scaled network diagram including all construction activities for the Project but showing the Contractor's proposed logic and order of activities during the first 120 days after the Notice to Proceed.

2.2 Schedule of Values (SOV)

- A. Activity List: The OPS shall be a "cost-loaded" schedule. Each activity comprising the OPS shall have a value or a cost assigned to it. As such, the Schedule of Values is actually a complete listing of the OPS' activities and corresponding values.
- B. Format: Produce the SOV in the Microsoft Excel spreadsheet program. Submit the review copy of the SOV on 8 ½-inch x 11-inch paper and provide an electronic copy on a CD.
- C. Activity Identification: The SOV shall include the description, value, and identification number of each OPS activity. Each identification number of each activity shall be identical to each activity ID number assigned in the OPS. The activity list and SOV shall be identical to and used to produce the schedule of values for the payment requisitions further defined in Section 01 29 73 – Schedule of Values.
- D. Values: The value of each activity shall be a complete and total value, including all taxes, overhead, and profit. The sum of all the values of the activities shall equal the total Contract value.
- E. Stored Material: Activities for which progress payment will be requested for stored material shall be broken down into at least two activities. The first activity shall be the cost of the material, delivered and unloaded, including taxes. The second activity shall be the cost of installation plus overhead and profit. Only the activities broken out in the SOV as described above shall be paid as a stored material. Equipment shall be broken down further to include activities and values for commissioning and start-up and operator training.
- F. Draw Projection: Along with the SOV submittal, provide a monthly draw projection indicating the estimated value of each monthly payment request. The draw projection shall be developed from the cash loaded schedule and shall be re-submitted with each monthly update of the OPS.

2.3 Overall Project Schedule (OPS)

- A. The Contractor shall submit to the Engineer for approval a detailed construction schedule detailing the proposed operations for the duration of the Project.

1. A resource loaded Critical Path Method (CPM) schedule covering the entire Project and completely detailing the Contractor's proposed operations for the construction of the work. The CPM Schedule shall be comprised of at least 1,000 activities comprised of approximately 200 administrative activities and 800 construction activities.
 2. A mathematical analysis of the CPM network diagram.
 3. A trend chart showing early, on time, and late completion envelopes, and actual progress trend since the start of the Project.
 4. A narrative report that describes the Contractor's planned actions of carrying out each phase and portion of the Work and summarizes the current status and progress of the Work. The report shall include descriptions of temporary construction, facility disruptions, and Owner's staff interface and coordination needs. The number of workers, including subcontractors, currently on-site (separated by trade) and shift shall be indicated, as well as the type and size of each major piece of equipment required for the Work.
- B. In preparing the OPS, the Contractor shall meet individually with each subcontractor. Each subcontractor shall provide the Contractor and the scheduling Consultant/In-house Resource with detailed activity information, including manpower requirements and appropriate durations, to complete each element of the Project. Each subcontractor shall also provide the Contractor with anticipated shop drawing and submittal dates and fabrication and delivery durations for key construction materials, systems, and equipment. For subcontractors and vendors not selected at the time of this data collection, the Contractor shall provide provisional data. Such provisional data shall later be reviewed with those subcontractors and vendors as they are selected, and the OPS adjusted as necessary.
- C. The CPM Network Diagram shall
1. Be prepared in the form of a time scaled CPM network.
 2. Group activities by building, structure, facility, and major exterior area of work, such as yard piping and electrical underground distribution. The identification number of the individual activities shall be coded such to provide the grouping.
 3. Be prepared in the chronological order of the beginning of each item of work.
 4. Identify each column or path by:
 - a. Distinct graphic delineation.
 - b. Major structures.
 5. Have a horizontal time scale based on calendar days and identify the Monday of each week.

6. Show the order and interdependence of the activities and the sequence in which the work is to be accomplished as planned by the Contractor. The diagram shall show how the start of a given activity is dependent upon the completion of the preceding activities and how its completion restricts the start of following activities. Float need not be shown on the network diagram.
7. Be prepared in such a manner that sub networks relating to particular phases or portions of the work can be readily extracted or revised. Such sub networks shall include, but may not be limited to, the following portions of the Work:
 - a. Each major piece of equipment.
 - b. Each primary system.
 - c. Activities to be performed in limited access areas or requiring interface with other Contractors.
 - d. Structures.
8. Show the following information related to the activities:
 - a. Activity number.
 - b. Activity description.
 - c. Estimated duration, in working days, of each activity.
 - d. Value of each activity, including profit, overhead, and taxes.
 - e. Manpower requirement, man hours.
 - f. If the precedence method of diagramming is being used, lags or lag factors may be used at the Contractor's option.
9. Show all activities relating to the construction of the work. Activities that are interdependent due to restrictions to available manpower, construction equipment, or site restraints shall also be shown.
10. Show all temporary construction activities required for permanent work.
11. Show where existing facilities will be taken out of service.
12. Show the following events and milestones in addition to construction activities:
 - a. Notice to Proceed.
 - b. Operating Test Period prior to the completion date.
 - c. Milestone dates.
 - d. Owner coordination.

- e. Notification periods.
 - f. Coordination with separate contracts.
 - g. Owner activities impacting the Work.
13. Provide the network information detail such that the duration of activities will generally range from 3 to 20 days, with not more than one percent of those activities outside those limits. The activities which comprise separate portions of the work shall be separately identifiable by coding.
14. Be plotted on 22-inch by 34-inch size sheets with the flow of activities from left to right. Printing shall be in color and suitable for half size reproduction. No lettering or numbering shall be less than 1/8 inch in height for capitals and numbers. The critical path shall be clearly marked and readily identifiable. Wherever possible, the activities relating to a particular sub network shall be grouped together on a single sheet.
15. Show the following for shop drawings, product data, and samples of major equipment and materials:
- a. Submittal date.
 - b. Review period, based on 30 calendar day review period by the Engineer.
 - c. Fabrication duration.
 - d. Delivery dates.
16. Show decision dates for selection of finishes or products.
17. Show Adverse Weather Days
- a. Show adverse weather days on the critical path. The number of adverse weather days per month shown on the critical path of the schedule shall not be less than the mean number of days for that particular month in which precipitation meets or exceeds 1/10 inch.
 - b. The mean number of days in which the precipitation meets or exceeds 1/10-inch will be based upon a 30-year average of precipitation recorded by the closest reporting weather station and described in the National Oceanic and Atmospheric Administration (NOAA) publication "Climatology of the United States No. 20", phone number (704) 259-0871 (www.noaa.org).
 - c. The total number of adverse weather days shall be monitored and agreed to monthly. The OPS shall be updated to reflect the accrual of the normal number of adverse weather days and the accrual of days beyond the norm.

D. Mathematical Analysis

1. The mathematical analysis of the network diagram shall be based on the network diagram and shall be a computer printout tabulating each activity and showing the following information for each activity:
 - a. Activity number or label if the precedence method of diagramming is being used, or the preceding and following event numbers if the arrow method of diagramming is being used.
 - b. Activity description.
 - c. Estimated duration, in working days of each activity.
 - d. Earliest start date, by calendar date.
 - e. Earliest finish date, by calendar date.
 - f. Latest start date, by calendar date.
 - g. Latest finish date, by calendar date.
 - h. Total float.
 - i. Critical activities and activities on the critical path shall be marked.
2. The earliest start and finish dates shall be regarded as the Contractor's intended start and finish dates.
3. In addition, the Contractor shall provide the Engineer with the following:
 - a. The Primavera or Microsoft Project generated calendar used for computation of the dates specified, showing the calendar dates of each working day, and shall incorporate the Contractor's assumptions of working days, with due consideration being given to discretionary, legal and statutory holidays, Saturdays and Sundays, and weather shutdowns.
 - b. A list of symbols and codes used in the preparation of the network diagram.
4. All standard Primavera or Microsoft Project generated reports.

2.4 Near Term Schedule (NTS)

- A. The Contractor shall develop and refine a detailed Near Term Schedule showing the day to day activities with committed completion dates which must be performed during the upcoming four to six week period. The detailed schedule shall represent the Contractor's best approach to the Work which must be accomplished to maintain progress consistent with the Overall Project Schedule. The NTS must show

proposed plant disruptions, the length of the disruption and key Owner interface activities.

Part 3 Execution

3.1 Updating

- A. Update Submittals: The OPS update shall coincide with the end of the pay period. The update shall be used to create the monthly payment requisition. No monthly payment requisition will be processed unless the OPS is updated and submitted to the Engineer.
- B. Written Narrative Report: Provide a written narrative report with each update including:
 - 1. A status review of the Project.
 - 2. A discussion of problem areas including current and anticipated delay factors and their impact.
 - 3. Direct action taken, or proposed, and its effect.
 - 4. A description of revisions including:
 - a. Their effect on the schedule due to the change of scope.
 - b. Revisions in duration of activities.
 - c. Other changes that may affect the schedule.
 - 5. A listing of behind schedule materials and equipment procurement activities. This list is an update of the submittal, manpower and key monthly completion and delivery dates, showing the OPS task number.
 - 6. Job progress relative to the OPS, including an Early/Late Start, Early/Late Finish and Total Float Report.
 - 7. A listing of any significant changes in the activities and restraints occurring since the last update and why the changes were made.
- C. CPM Network Diagram
 - 1. An updated diagram with all activities and restraints shall be furnished. This includes providing an "As Built" Schedule with completion dates to the OPS for all key monthly completion and delivery dates. All approved change orders should be listed and the effects of change orders on the OPS shown.

2. Provide updated OPS graphics in color showing progress-to-date and completion schedule. The critical path or paths shall be clearly identified.
 3. OPS graphics shall include a histogram showing labor manpower loading.
- D. Trend Chart: Provide a trend chart showing Project completion dates of significant areas of the Project.
 - E. Critical Work List: Provide a listing of critical work to be performed prior to the next Project Progress Meeting, specifically listing what must be done during the next 30 days to stay on the OPS critical path schedule and its task number.
 - F. At each Project Coordination Meeting, the Contractor shall present for discussion the most current update of the OPS and NTS.

3.2 Scheduling Staff

- A. The Contractor shall employ or retain the services of at least one person fully qualified and experienced in critical path scheduling utilizing the P6 or Microsoft Project program for the duration of the Contract. The Contractor must use a qualified scheduling consultant/In-house resource to develop the OPS and to produce subsequent updates. Such person or persons shall cooperate with the corresponding person or persons on the Engineer's staff and shall continuously update the Contractor's detailed construction Overall Project Schedule and assist the Contractor's on-site project management.

END OF SECTION

Part 1 General

1.1 Scope

- A. The Contractor shall furnish all equipment and labor materials required to provide the Owner with digital construction videos and photographs of the Project.
- B. Regular Construction Progress Photos. Contractor shall document, on a monthly basis, key components of the construction progress.

1.2 Submittals

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Contractor shall submit and/or upload electronic files of each view to the Engineer. Submit image files within three calendar days of taking photographs.
 - 1. Digital Camera: Minimum resolution of 3600 by 2400, minimum 10 megapixels.
 - 2. Format: Minimum 3600 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, un-cropped, in folder named by date of photograph, accompanied by key plan file.
 - 3. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project
 - b. Project number.
 - c. Building/structure name.
 - d. Name and contact information for photographer.
 - e. Name of Engineer.
 - f. Name of Contractor.
 - g. Date photographs were taken.
 - h. Weather conditions.
 - i. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - j. Unique sequential identifier keyed to accompanying key plan.

Construction Videos and Photographs

- C. Construction Videos: Contractor shall upload one copy of each video to Engineer within 7 days of recording.
 - 1. Identify each video with the same identification information stated under Digital Photographs.
 - 2. Transcript: Photographer shall upload an electronic narrative for each video with each video submission. Include the same label information as provided on the corresponding video.
- D. Photo and video files shall become the property of the Owner and none of the videos or photographs shall be published without express permission of the Owner.

Part 2 Products

2.1 Photographic Media

- A. Digital Images: JPEG format with minimum sensor size of 3600 by 2400, minimum 10 megapixels.
- B. Video Format: Standard definition DVDs, CDs, or USB Flash Drive.
 - 1. Identification: Each copy shall have an applied label containing the same identification information stated under Digital Photographs

Part 3 Execution

3.1 Construction Photographs

- A. Preconstruction Photographs: Before construction is started, photographer shall take photographs of the site and surrounding properties from different points of view selected Engineer. The contractor may choose to provide additional photographs.
 - 1. Take not less than 10 photographs to show the context of the work area both interior and exterior as required by the scope of services, of existing buildings and conditions adjacent to the project in sufficient detail to record the physical conditions at the start of construction.
 - 2. In addition, take not less than one birds-eye aerial photograph from a drone, helicopter or low-flying airplane at an elevation to clearly show the full project site and nearby adjacent conditions.
- B. Construction Period Photographs: At intervals during construction, photographer shall take photographs of the project's progress from different points of view. Vantage points shall be selected by the photographer unless otherwise directed by Engineer.
 - 1. Frequency: Take photographs monthly coinciding with the cutoff date associated with each application for payment.
 - 2. Number: Take not less than 4 photographs each time, to best show the status of construction and progress since taking previous photographs.

3.2 Construction Videos

- A. Video: Camera shall be mounted on a tripod before starting recording, unless otherwise necessary to show area of construction. Continuous running time shall be displayed at all times. At the start of each video, weather conditions shall be recorded, including temperature reading at the project site.
 - 1. Narration: Describe scenes on video by dubbing audio narration offsite after video is recorded. Include description of items being viewed, events that have recently happened, and activities that are planned. Describe vantage point.
 - 2. Transcript: Provide an electronic transcript of the narration. Include images and running time captured from video, displayed opposite the corresponding narration segment.
- B. Preconstruction Video: Before construction is started, photographer shall record video of the site and surrounding properties from different points of view selected by Engineer.

END OF SECTION

Part 1 General

1.1 Scope

- A. The work under this Section includes submittal to the Engineer of shop drawings, product data and samples required by the various Sections of these Specifications.
- B. Submittal Contents: The submittal contents required are specified in each Section.
- C. Definitions: Submittals are categorized as follows:
 - 1. Shop Drawings
 - a. Shop drawings shall include technical data, drawings, diagrams, procedure and methodology, performance curves, schedules, templates, patterns, test reports, calculations, instructions, measurements and similar information as applicable to the specific item for which the shop drawing is prepared.
 - b. Provide newly-prepared information with graphic information at accurate scale (except as otherwise indicated) with name or preparer (firm name) indicated. The Contract Drawings shall not be reproduced by any method for use as or in lieu of detail shop drawings. Show dimensions and note dimensions that are based on field measurement. Identify materials and products in the work shown. Indicate compliance with standards and special coordination requirements. Do not allow shop drawings to be used in connection with the Work without appropriate final "Action" markings by the Engineer.
 - c. Drawings shall be presented in a clear and thorough manner. Details shall be identified by reference to sheet and detail, Specification Section, schedule or room numbers shown on the Contract Drawings.
 - d. Minimum assembly drawings sheet size shall be 11 x 17-inches.
 - e. Minimum detail sheet size shall be 8-1/2 x 11-inches.
 - f. Minimum Scale:
 - i. Assembly Drawings Sheet, Scale: 1-inch = 30 feet.
 - ii. Detail Sheet, Scale: 1/4-inch = 1 foot.
 - 2. Product Data
 - a. Product data includes standard published information on materials, products and systems, not specially prepared for this Project, other than the designation of selections from among available choices printed therein.

- b. Collect required data into one submittal for each unit of work or system and mark each copy to show which choices and options are applicable to the Project. Include manufacturer's standard published recommendations for application and use, compliance with standards, application of labels and seals, notation of field measurements which have been checked and special coordination requirements.
- 3. Samples
 - a. Samples include both fabricated and un-fabricated physical examples of materials, products and units of work, both as complete units and as smaller portions of units of work, either for limited visual inspection or, where indicated, for more detailed testing and analysis.
 - b. Provide units identical with final condition of proposed materials or products for the work. Include "range" samples, not less than three units, where unavoidable variations must be expected, and describe or identify variations between units of each set. Provide full set of optional samples where the Engineer's selection is required. Prepare samples to match the Engineer's sample where indicated. Include information with each sample to show generic description, source or product name and manufacturer, limitations and compliance with standards. Samples are submitted for review and confirmation of color, pattern, texture and "kind" by the Engineer. Engineer will note "test" samples, except as otherwise indicated, for other requirements, which are the exclusive responsibility of the Contractor.
- 4. Miscellaneous submittals related directly to the work (non-administrative) include warranties, maintenance agreements, workmanship bonds, project photographs, survey data and reports, physical work records, statements of applicability, quality testing and certifying reports, copies of industry standards, record drawings, field measurement data, operating and maintenance materials, overrun stock, security/protection/safety keys and similar information, devices and materials applicable to the work but not processed as shop drawings, product data or samples.

1.2 Specific Category Requirements

- A. General: Except as otherwise indicated in the individual work sections, comply with general requirements specified herein for each indicated category of submittal. Submittals shall contain:
 - 1. The date of submittal and the dates of any previous submittals.
 - 2. The Project title.
 - 3. Unless indicated otherwise by the Engineer's submittal management software, provide numerical submittal numbers, starting with 1.0, 2.0, etc. Revisions to be numbered 1.1, 1.2, etc.

4. The Names of:
 - a. Contractor
 - b. Supplier
 - c. Manufacturer
5. Identification of the product, with the Specification Section number, permanent equipment tag numbers and applicable Drawing No.
6. Field dimensions, clearly identified as such.
7. Relation to adjacent or critical features of the work or materials.
8. Applicable standards, such as ASTM.
9. Notification to the Engineer in writing, at time of submissions, of any deviations on the submittals from requirements of the Contract Documents.
10. Identification of revisions on resubmittals.
12. Contractor's stamp, initialed or signed or affirmatively indicated on submittal, certifying to review of submittal, verification of products, field measurements and field construction criteria and coordination of the information within the submittal with requirements of the work and of Contract Documents.
13. Submittals showing more than the particular item under consideration shall have all but the pertinent description of the item for which review is requested crossed out.

1.3 Routing of Submittals

- A. Submittals and routine correspondence shall be routed as follows:
 1. Supplier to Contractor (through representative if applicable)
 2. Contractor to Engineer
 3. Engineer to Contractor and Owner
 4. Contractor to Supplier

Part 2 Products

2.1 Shop Drawings

- A. Unless otherwise specifically directed by the Engineer, make all shop drawings accurately to a scale sufficiently large to show all pertinent features of the item and its method of connection to the work.
- B. Submit all shop assembly drawings, as a digital image, pdf format, scanned at the original scale.
- C. Submit all shop drawings as a digital image, pdf format, scanned at the original scale.

2.2 Manufacturer's Literature

- A. Where content of submitted literature from manufacturers includes data not pertinent to this submittal, clearly indicate which portion of the contents is being submitted for the Engineer's review.

2.3 Samples

- A. Samples shall illustrate materials, equipment or workmanship and established standards by which completed work is judged.
- B. Unless otherwise specifically directed by the Engineer, all samples shall be of the precise article proposed to be furnished.
- C. Submit all samples in the quantity which is required to be returned plus one sample which will be retained by the Engineer.

2.4 Colors

- A. Unless the precise color and pattern is specifically described in the Contract Documents, wherever a choice of color or pattern is available in a specified product, submit accurate color charts and pattern charts to the Engineer for review and selection.
- B. Unless all available colors and patterns have identical costs and identical wearing capabilities, and are identically suited to the installation, completely describe the relative costs and capabilities of each.

Part 3 Execution

3.1 Contractor's Coordination of Submittals

- A. Prior to submittal for the Engineer's review, the Contractor shall use all means necessary to fully coordinate all material, including the following procedures:

1. Determine and verify all field dimensions and conditions, catalog numbers and similar data.
 2. Coordinate as required with all trades and all public agencies involved.
 3. Submit a written statement of review and compliance with the requirements of all applicable technical Specifications as well as the requirements of this Section.
 4. Clearly indicate in a letter or memorandum on the manufacturer's or fabricator's letterhead, all deviations from the Contract Documents.
- B. Each and every shop drawing and data sheet submittal shall bear the Contractor's stamp showing that they have been so checked. Shop drawings submitted to the Engineer without the Contractor's stamp will be returned to the Contractor for conformance with this requirement.
- C. The Owner may backcharge the Contractor for costs associated with having to review a particular shop drawing, product data or sample more than two times to receive a "No Exceptions Taken" mark.
- D. Grouping of Submittals
1. Unless otherwise specifically permitted by the Engineer, make all submittals in groups containing all associated items.
 2. No review will be given to partial submittals of shop drawings for items which interconnect and/or are interdependent. It is the Contractor's responsibility to assemble the shop drawings for all such interconnecting and/or interdependent items, check them and then make one submittal to the Engineer along with Contractor's comments as to compliance, non-compliance or features requiring special attention.
- E. Schedule of Submittals
1. Within 30 days of Contract award and prior to any shop drawing submittal, the Contractor shall submit a schedule showing the estimated date of submittal and the desired approval date for each shop drawing anticipated. A reasonable period shall be scheduled for review and comments. Time lost due to unacceptable submittals shall be the Contractor's responsibility and some time allowance for resubmittal shall be provided. The schedule shall provide for submittal of items which relate to one another to be submitted concurrently.

3.2 Timing of Submittals

- A. Make all submittals far enough in advance of scheduled dates for installation to provide all required time for reviews, for securing necessary approvals, for possible revision and resubmittal, and for placing orders and securing delivery.
- B. In scheduling, allow sufficient time for the Engineer's review following the receipt of the submittal.

3.3 Reviewed Shop Drawings

A. Engineer Review

1. Allow a minimum of 30 days for the Engineer's initial processing of each submittal requiring review and response, except allow longer periods where processing must be delayed for coordination with subsequent submittals. The Engineer will advise the Contractor promptly when it is determined that a submittal being processed must be delayed for coordination. Allow a minimum of two weeks for reprocessing each submittal. Advise the Engineer on each submittal as to whether processing time is critical to progress of the work, and therefore the work would be expedited if processing time could be foreshortened.
2. Acceptable submittals without any comments will be marked "No Exceptions Taken".
3. Submittals containing comments for clarification will be marked "Exceptions Noted".
4. Submittals marked "Revise and Resubmit" must be revised to reflect required changes and the initial review procedure repeated.
5. The "Rejected" notation is used to indicate products which are not acceptable. Upon return of a submittal so marked, the Contractor shall repeat the initial review procedure utilizing acceptable products.

B. No work or products shall be installed without a drawing or submittal bearing the "No Exceptions Taken" notation. The Contractor shall maintain at the job site a complete set of shop drawings bearing the Engineer's stamp.

C. Substitutions: In the event the Contractor obtains the Engineer's approval for the use of products other than those which are listed first in the Contract Documents, the Contractor shall, at the Contractor's own expense and using methods approved by the Engineer, make any changes to structures, piping and electrical work that may be necessary to accommodate these products.

D. Use of the "No Exceptions Taken" notation on shop drawings or other submittals is general and shall not relieve the Contractor of the responsibility of furnishing products of the proper dimension, size, quality, quantity, materials and all performance characteristics, to efficiently perform the requirements and intent of the Contract Documents. The Engineer's review shall not relieve the Contractor of responsibility for errors of any kind on the shop drawings. Review is intended only to assure conformance with the design concept of the Project and compliance with the information given in the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site. The Contractor is also responsible for information that pertains solely to the fabrication processes or to the technique of construction and for the coordination of the work of all trades.

3.4 Resubmission Requirements

A. Shop Drawings

1. Revise initial Drawings as required and resubmit as specified for initial submittal, with the resubmittal number shown.
2. Indicate on Drawings all changes which have been made other than those requested by the Engineer.

B. Project Data and Samples: Resubmit new data and samples as specified for initial submittal, with the resubmittal number shown.

END OF SECTION

Part 1 General

1.1 Scope

- A. The scope of this Section is to convey to the Contractor unique and unusual stipulations and requirements which have been established for this Project. Some of the stipulations and requirements are a result of negotiations with various entities and organizations which have an interest in this Project. Some requirements are based on technical aspects of the Project which are not otherwise conveyed to the Contractor. The provisions of this Section shall supersede the provisions of the Division 01 through 49 Specifications but shall not supersede the Bidding Requirements, Contract Forms or Conditions of the Contract.

1.2 Milestone Dates

(NOT USED)

1.3 Submittals

- A. Sequence Submittal
 - 1. Submit a proposed sequence in accordance with Section 01 33 00 with appropriate times of starting and completion of tasks to Engineer for review.
 - 2. The Contractor may propose alternatives to the sequencing constraints to that shown in this Section in an attempt to reduce the disruption of the operation of the existing facility or streamline the tasks of this Contract. The Owner and Engineer are not obligated to accept any of these alternatives.

1.4 Existing Facility Operations

- A. The Contractor shall coordinate the work with the Owner so that the construction will not restrain or hinder the operation of the existing facilities. If, at any time, any portion of the facilities are out of service, the Contractor must obtain approval from the Owner as to the date, time and length of time that portion of the facilities are out of service.
- B. Connections to the existing facilities or alteration of existing facilities will be made at times when the facility involved is not in use or at times, established by the Owner, when the use of the facility can be conveniently interrupted for the period of time needed to make the connection or alteration.
- D. After having coordinated the work with the Owner, the Contractor shall prepare a submittal in accordance with Section 01 33 00 to include the time, time limits and methods of each connection or alteration and have the approval of the Engineer before any work is undertaken on the connections or alterations.
- E. Before any roadway or facilities are blocked off, the Owner's approval shall be obtained to coordinate operations for the plant.

1.5 Sequencing

A. General

1. The Contractor shall be solely responsible for all construction sequencing.
2. The completion of specific preliminary sequencing tasks will be required prior to any significant site demolition.
3. The construction schedule and tasks shall be reviewed and approved by the Engineer before site demolition begins.

- B. Notify the Owner at least ten days prior to starting to relocate piping or taking existing components out of service.

1.6 Sequencing Constraints

- A. The following construction sequencing constraints are to emphasize critical tasks of the Work in this Contract. It is not a complete list of all work to be completed.
- B. The capacity of the facility to dewater sludge shall not be reduced during construction. The Contractor shall supply temporary dewatering facilities in accordance with Section 01 51 43.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

A. Permits and Responsibilities

1. The Contractor shall, without additional expense to the Owner, be responsible for obtaining all necessary licenses and permits, including building permits, and for complying with any applicable federal, state, county and municipal laws, codes and regulations, in connection with the prosecution of the work.
2. The Contractor shall secure and obtain the Land Disturbance Permit (LDP) from Whitfield County. The LDP fee and plans have been submitted to Whitefield County with the project ID of WCLDP2019-001.

B. The Contractor shall take proper safety and health precautions to protect the work, the workers, the public and the property of others.

C. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the work, except for any completed unit of construction thereof which may heretofore have been accepted.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Description

- A. Whenever reference is made to conforming to the standards of any technical society, organization, body, code or standard, it shall be construed to mean the latest standard, code, specification or tentative specification adopted and published at the time of advertisement for bids. This shall include the furnishing of materials, testing of materials, fabrication and installation practices. In those cases where the Contractor's quality standards establish more stringent quality requirements, the more stringent requirement shall prevail. Such standards are made a part hereof to the extent which is indicated or intended.
- B. The inclusion of an organization under one category does not preclude that organization's standards from applying to another category.
- C. In addition, all work shall comply with the applicable requirements of local codes, utilities and other authorities having jurisdiction.
- D. All material and equipment, for which a UL Standard, an AGA or NSF approval or an ASME requirement is established, shall be so approved and labeled or stamped. The label or stamp shall be conspicuous and not covered, painted, or otherwise obscured from visual inspection.
- E. The standards which apply to this Project are not necessarily restricted to those from organizations which are listed in Article 1.2.

1.2 Standard Organizations

A. Piping and Valves

ACPA	American Concrete Pipe Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
DIPRA	Ductile Iron Pipe Research Association
FCI	Fluid Controls Institute
MSS	Manufacturers Standardization Society
NCPI	National Clay Pipe Institute
NSF	National Sanitation Foundation
PPI	Plastic Pipe Institute
Uni-Bell	PVC Pipe Association

Codes and Standards

B. Materials

AASHTO American Association of State Highway and Transportation Officials
ANSI American National Standards Institute
ASTM American Society for Testing and Materials

C. Painting and Surface Preparation

NACE National Association of Corrosion Engineers
SSPC Steel Structures Painting Council

D. Electrical and Instrumentation

AEIC Association of Edison Illuminating Companies
AIEE American Institute of Electrical Engineers
EIA Electronic Industries Association
ICEA Insulated Cable Engineers Association
IEC International Electrotechnical Commission
IEEE Institute of Electrical and Electronic Engineers
IES Illuminating Engineering Society
IPC Institute of Printed Circuits
IPCEA Insulated Power Cable Engineers Association
ISA The Instrumentation, Systems, and Automation Society
NEC National Electric Code
NEMA National Electrical Manufacturers Association
NFPA National Fire Protection Association
REA Rural Electrification Administration
TIA Telecommunications Industries Association
UL Underwriter's Laboratories
VRCI Variable Resistive Components Institute

E. Aluminum

AA Aluminum Association
AAMA American Architectural Manufacturers Association

F. Steel and Concrete

ACI American Concrete Institute
AISC American Institute of Steel Construction, Inc.
AISI American Iron and Steel Institute
CRSI Concrete Reinforcing Steel Institute
NRMA National Ready-Mix Association
PCA Portland Cement Association
PCI Prestressed Concrete Institute

G. Welding

ASME American Society of Mechanical Engineers
AWS American Welding Society

H. Government and Technical Organizations

AIA	American Institute of Architects
APHA	American Public Health Association
APWA	American Public Works Association
ASA	American Standards Association
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASQC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
CFR	Code of Federal Regulations
CSI	Construction Specifications Institute
EDA	Economic Development Administration
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
FmHA	Farmers Home Administration
FS	Federal Specifications
IAI	International Association of Identification
ISEA	Industrial Safety Equipment Association
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
NBFU	National Board of Fire Underwriters
(NFPA)	National Fluid Power Association
NBS	National Bureau of Standards
NISO	National Information Standards Organization
OSHA	Occupational Safety and Health Administration
SI	Salt Institute
SPI	The Society of the Plastics Industry, Inc.
USDC	United States Department of Commerce
WEF	Water Environment Federation

I. General Building Construction

AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AITC	American Institute of Timber Construction
APA	American Parquet Association, Inc.
APA	American Plywood Association
BHMA	Builders Hardware Manufacturers Association
BIFMA	Business and Institutional Furniture Manufacturers Association
DHI	Door and Hardware Institute
FM	Factory Mutual Fire Insurance Company
HPMA	Hardwood Plywood Manufacturers Association
HTI	Hand Tools Institute
IME	Institute of Makers of Explosives
ISANTA	International Staple, Nail and Tool Association
ISDSI	Insulated Steel Door Systems Institute
IWS	Insect Screening Weavers Association
MBMA	Metal Building Manufacturers Association
NAAMM	National Association of Architectural Metal Manufacturers
NAGDM	National Association of Garage Door Manufacturers

Codes and Standards

NCCLS	National Committee for Clinical Laboratory Standards
NFPA	National Fire Protection Association
NFSA	National Fertilizer Solutions Association
NKCA	National Kitchen Cabinet Association
NWMA	National Woodwork Manufacturers Association
NWWDA	National Wood Window and Door Association
RMA	Rubber Manufacturers Association
SBC	SBCC Standard Building Code
SDI	Steel Door Institute
SIA	Scaffold Industry Association
SMA	Screen Manufacturers Association
SPRI	Single-Ply Roofing Institute
TCA	Tile Council of America
UBC	Uniform Building Code

J. Roadways

AREA	American Railway Engineering Association
DOT	Department of Transportation

K. Plumbing

AGA	American Gas Association
NSF	National Sanitation Foundation
PDI	Plumbing Drainage Institute
SPC	SBCC Standard Plumbing Code

L. Refrigeration, Heating, and Air Conditioning

AMCA	Air Movement and Control Association
ARI	American Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
CGA	Compressed Gas Association
CTI	Cooling Tower Institute
HEI	Heat Exchange Institute
IIAR	International Institute of Ammonia Refrigeration
NB	National Board of Boilers and Pressure Vessel Inspectors
PFMA	Power Fan Manufacturers Association
SAE	Society of Automotive Engineers
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SMC	SBCC Standard Mechanical Code
TEMA	Tubular Exchangers Manufacturers Association

M. Equipment

AFBMA	Anti-Friction Bearing Manufacturers Association, Inc.
AGMA	American Gear Manufacturers Association
ALI	Automotive Lift Institute
CEMA	Conveyor Equipment Manufacturers Association

CMAA	Crane Manufacturers Association of America
DEMA	Diesel Engine Manufacturers Association
MMA	Monorail Manufacturers Association
OPEI	Outdoor Power Equipment Institute, Inc.
PTI	Power Tool Institute, Inc.
RIA	Robotic Industries Association
SAMA	Scientific Apparatus Makers Association

1.3 Symbols

- A. Symbols and material legends shall be as scheduled on the Drawings.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. The work under this Section defines the minimum scope of services to be provided by the Contractor during installation, start-up, operating test period, and operator training using factory representatives of the manufacturers of the equipment provided.
- B. Furnish all labor, materials, tools, equipment, and services for the cleaning up or preparation of all equipment which is required in conjunction with the instruction work to be performed for the Owner's personnel.
- C. Perform additional instruction of the Owner's personnel for any and all items of work that are incomplete at the time initial instruction sessions are scheduled.
- D. Although such work may not be explicitly specifically indicated elsewhere, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation, and to provide instructions upon the functions of that installation.
- E. Provide instruction for all equipment and systems for which operating and maintenance data is required.
- F. Instruction sessions may be combined to some extent between several pieces of similar equipment within the same training session, but only if that combination is defined in the Contractor's instruction program submittal and approved by the Engineer.
- G. One instruction session for each major type of equipment will be required. The Contractor shall anticipate that up to ten of the Owner's employees will participate in any particular instruction session and shall be prepared to provide the required number of handouts, manuals, and tools for each session.

1.2 Qualification

- A. Qualification of the manufacturer's representatives for installation, start-up, and operator training purposes shall be appropriate for the equipment being installed. Manufacturer's representatives shall be subject to the approval of the Engineer. Where equipment has significant process complexity, furnish the services of engineering personnel knowledgeable in the process involved and the function of the equipment.
- B. References in various equipment sections of the terms "factory representative" or "field representative" shall mean an employee of the equipment manufacturer who is completely knowledgeable of the manufacturing, installation, operation and maintenance of the equipment. A sales representative does not qualify, unless it is documented that they have been specifically trained by the Manufacturer. Any field or factory representative not an active employee of the manufacturer must provide documentation from the manufacturer stating that the individual, by name, has been

formally trained in the installation, operation and maintenance of the equipment and is authorized to make the required certification to perform the required services.

1.3 Submittals

- A. No later than one hundred twenty days prior to scheduled Substantial Completion of the Work, the Contractor shall submit a list of proposed instruction sessions for the entire Project. This list shall be organized by Specification Section and its contents will be subject to the approval of the Engineer and Owner.
- B. After approval of the list of the proposed instruction sessions and no later than sixty days prior to the scheduled Substantial Completion of the Work, submit course outlines and training material for each of the approved instruction sessions. Outlines shall be organized by Specification Section, and their contents shall be subject to the approval of the Engineer.
- C. After approval of the program content, the Contractor shall submit a proposed schedule for each of the approved instruction sessions which are to be organized by Specification Section, and the scheduled dates will be subject to the approval of the Engineer.
- D. Submit a separate instruction request/report (form attached) for each system or type of equipment, subject to the Owner's approval of availability of personnel.
 - 1. Submit request/report with preliminary information indicated, to the Engineer at least two weeks prior to first instruction period.
 - 2. After each instruction session, submit three copies of the completed report to the Engineer.

1.4 Coordination

- A. Do not begin instructions until component assembly or system has been tested as specified in Section 01 75 16 and is in satisfactory operating condition.
- B. Prior to instruction sessions, assemble instructional aids, tools, test equipment, and "Final" copies of Operations and Maintenance Manuals.
- C. All instruction sessions shall be planned and scheduled such that the Owner's participants will utilize copies of the Project Operations and Maintenance Manuals which will have been previously provided. These copies are in addition to the quantities which have to be provided to the Owner under Section 01 78 23. The use of draft copies of these manuals will be acceptable.
- D. The Contractor shall schedule and coordinate the visits of factory representatives during installation, start-up and operator training in accordance with the requirements of Section 01 75 16 of these Specifications.
- E. The Contractor shall notify the Engineer 72 hours prior to any impending visit by factory representatives so that the Engineer can be present.

1.5 Installation, Start-Up, and Testing Services

- A. The Contractor shall furnish the services of a factory representative to provide the Pre-Start-Up Maintenance, Installation, Inspection, Functional Testing, and Operational Testing in accordance with Section 01 75 16 and the equipment sections of these Specifications.

1.6 Operator Training Services

- A. Provide all instruction as required to ensure understanding of all operating and maintenance procedures by the Owner designated personnel.
- B. Instruct Owner's personnel in operation and maintenance of equipment and systems. Provide all necessary instruction to satisfaction of the Owner.
- C. Training sessions shall be scheduled at the convenience of the Owner and may have to be scheduled outside of the Contractor's normal working hours.
- D. Explain use of Operating and Maintenance Manuals.
- E. Tour building areas involved and identify:
 - 1. Maintenance and access points.
 - 2. Control locations and control equipment.
- F. Explain Operating Sequences
 - 1. Identify location and show operation of switches, valves, etc., used to start, stop, and adjust systems.
 - 2. Explain use of flow diagrams, operating sequences, diagrams, etc.
 - 3. Demonstrate operation through complete cycle(s) and full range of operation in all modes, including testing and adjusting relevant to operation
- G. Explain use of control equipment, including temperature settings, switch modes, available adjustments, reading of gauges, and functions that must be serviced only by authorized factory representative.
- H. Explain Trouble Shooting Procedures
 - 1. Demonstrate commonly occurring problems.
 - 2. Note procedures which must be performed by factory personnel.
- I. Explain Maintenance Procedures and Requirements
 - 1. Point out items requiring periodic maintenance.

2. Demonstrate typical preventive maintenance procedures and recommend typical maintenance intervals.
 3. Demonstrate other commonly occurring maintenance procedures not part of preventive maintenance program.
 4. Identify maintenance materials to be used.
- J. Furnish all tools and/or test equipment required for proper instruction of the Owner's personnel. Tools and/or test equipment shall be distributed in "sets" with each two participants having a "set" to work with and retain upon completion of the instruction. Each participant shall sign for their tools at the start of the instruction session, and copies of the assignment documents shall be provided to the Engineer by the Contractor.
- K. Thirty-day operating period after start-up: The manufacturers' representative for each piece of equipment shall return to the Project site 30 days after successful completion of the operating test to review the equipment performance, correct any equipment problems, and conduct follow-up operation and maintenance classes as required by the Owner. This follow-up trip is required in addition to the specified services of manufacturer's representative prior to and during equipment start-up. At this time, if there are no equipment problems, each manufacturer shall certify to the Owner in writing that his equipment is fully operational and capable of meeting operating requirements. If the certification is accepted by the Engineer and Owner, the Contractor may request Substantial Completion inspection for the associated portion of the Work in accordance with provisions specified elsewhere in these contract Documents. If the equipment is operating incorrectly, the factory representative will make no certification to the Owner until the problems are corrected and the equipment demonstrates a successful 30 days operating period.
- L. Six-month operating period after start-up: The manufacturer's representative for each piece of equipment shall return to the Project site six months after the successful completion of the operating test to review the equipment performance, correct any equipment problems, and conduct follow-up operation and maintenance classes as required by the Owner. This follow-up trip is required in addition to the specified services of manufacturer's representative prior to and during equipment start-up. At the time of this trip, if there are no equipment problems, each manufacturer shall certify to the Owner in writing that his equipment is fully operational and capable of meeting operating requirements. If the equipment is operating incorrectly, the service representative will make no certification to the Owner until the problems are corrected and the equipment demonstrates a successful 30-day operating period after problems are corrected.

1.7 Documentation

- A. The Contractor shall obtain from all manufacturers an electronic file of all operation and training information and training presentation materials in searchable Adobe Acrobat Portable Document Format (PDF). The PDF file(s) shall be fully indexed using the Table of Contents, searchable with thumbnails generated. File(s) shall be

identified by specification section. All documents shall be scanned at 300dpi or greater utilizing optical character recognition (OCR) software. All text in the document must be text selectable with the exception of pages which are in their entirety drawings or diagrams. Word searches of the PDF document must function successfully. PDF files that fail to comply with the indexing and searchable features described above will not be acceptable.

- B. At the completion of each training session, the training session will be certified by representatives from the Manufacturer, Contractor, Owner and Engineer. A training attendance roster for each session identifying all participants shall be delivered by the Contractor to the Engineer.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

EQUIPMENT AND SYSTEMS INSTRUCTION REPORT

PROJECT: _____

SYSTEM OR EQUIPMENT: _____

CONTRACTOR NAME: _____ CONTRACT NO. _____

SPECIFICATION SECTION

NOTE: The Contractor's Representative must maintain and complete this report during instruction.

PRELIMINARY INFORMATION

1. To be completed by the Contractor:

A. Proposed dates for instruction period: From _____ To _____

B. Name of Representative Instructor: _____

C. Approximate number of hours of training required: _____

2. To be completed by the Owner:

A. Owner's Designated Personnel to receive instruction: (Identify supervisor, if required).

1) _____	6) _____
2) _____	7) _____
3) _____	8) _____
4) _____	9) _____
5) _____	10) _____

B. Training Session Location: _____

RECORD INFORMATION (To be Completed after Instruction Session)

Instructor's Signature: _____ Date Instruction Completed: _____

Engineer's Signature: _____

Owner's Signature: _____

SPECIAL CONSIDERATIONS/NOTES:

Part 1 General

1.1 Scope

- A. This Section includes testing which the Owner may require, beyond that testing required of the manufacturer, to determine if materials provided for the Project meet the requirements of these Specifications.
- B. This work also includes all testing required by the Owner to verify work performed by the Contractor is in accordance with the requirements of these Specifications, i.e., concrete strength and slump testing, soil compaction, etc.
- C. This work does not include materials testing required in various sections of these Specifications to be performed by the manufacturer, e.g., testing of pipe.
- D. The testing laboratory or laboratories will be selected by the Owner. The testing laboratory or laboratories will work for the Owner.

1.2 Payment for Testing Services

- A. The cost of testing services required by the Contract to be provided by the Contractor shall be paid for by the Owner through the CASH ALLOWANCE, i.e., concrete testing, soil compaction, and asphalt testing.
- B. The cost of additional testing services not specifically required in the Specifications, but requested by the Owner or Engineer, shall be paid for by the Owner through the CASH ALLOWANCE.
- C. The cost of material testing described in various sections of these Specifications or as required in referenced standards to be provided by a material manufacturer, shall be included in the price bid for that item and shall not be paid for by the Owner.
- D. The cost of retesting any item that fails to meet the requirements of these Specifications shall be paid for by the Contractor. Retesting shall be performed by the testing laboratory working for the Owner.

1.3 Laboratory Duties

- A. Cooperate with the Owner, Engineer and Contractor.
- B. Provide qualified personnel promptly on notice.
- C. Perform specified inspections, sampling and testing of materials.
 - 1. Comply with specified standards, ASTM, other recognized authorities, and as specified.
 - 2. Ascertain compliance with requirements of the Contract Documents.

- D. Promptly notify the Engineer and Contractor of irregularities or deficiencies of work which are observed during performance of services.
- E. Promptly submit three copies (two copies to the Engineer and one copy to the Contractor) of report of inspections and tests in addition to those additional copies required by the Contractor with the following information included:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Testing laboratory name and address.
 - 4. Name and signature of inspector.
 - 5. Date of inspection or sampling.
 - 6. Record of temperature and weather.
 - 7. Date of test.
 - 8. Identification of product and Specification section.
 - 9. Location of Project.
 - 10. Type of inspection or test.
 - 11. Results of test.
 - 12. Observations regarding compliance with the Contract Documents.
- F. Perform additional services as required.
- G. The laboratory is not authorized to release, revoke, alter or enlarge on requirements of the Contract Documents, or approve or accept any portion of the work.

1.4 Contractor Responsibilities

- A. Cooperate with laboratory personnel, provide access to work and/or comply with manufacturer's requirements.
- B. Provide to the laboratory, representative samples, in required quantities, of materials to be tested.
- C. Furnish copies of mill test reports.

- D. Furnish required labor and facilities to:
 - 1. Provide access to work to be tested;
 - 2. Obtain and handle samples at the site;
 - 3. Facilitate inspections and tests;
 - 4. Build or furnish a holding box for concrete cylinders or other samples as required by the laboratory.
- E. Notify the laboratory sufficiently in advance of operation to allow for the assignment of personnel and schedules of tests.
- F. Laboratory Tests: Where such inspection and testing are to be conducted by an independent laboratory agency, the sample(s) shall be selected by such laboratory or agency, or the Engineer, and shipped to the laboratory by the Contractor at Contractor's expense.
- G. Copies of all correspondence between the Contractor and testing agencies shall be provided to the Engineer.

1.5 Quality Assurance

- A. Testing shall be in accordance with all pertinent codes and regulations and with procedures and requirements of the American Society for Testing and Materials (ASTM).

1.6 Product Handling

- A. Promptly process and distribute all required copies of test reports and related instructions to insure all necessary retesting or replacement of materials with the least possible delay in the progress of the work.

1.7 Furnishing Materials

- A. The Contractor shall be responsible for furnishing all materials necessary for testing.

1.8 Code Compliance Testing

- A. Inspections and tests required by codes or ordinances or by a plan approval authority, and made by a legally constituted authority, shall be the responsibility of, and shall be paid for by the Contractor, unless otherwise provided in the Contract Documents.

1.9 Contractor's Convenience Testing

- A. Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

1.10 Schedules for Testing

A. Establishing Schedule

1. The Contractor shall, by advance discussion with the testing laboratory selected by the Owner, determine the time required for the laboratory to perform its tests and to issue each of its findings, and make all arrangements for the testing laboratory to be on site to provide the required testing.
2. Provide all required time within the construction schedule.

B. When changes of construction schedule are necessary during construction, coordinate all such changes of schedule with the testing laboratory as required.

C. When the testing laboratory is ready to test according to the determined schedule, but is prevented from testing or taking specimens due to incompleteness of the work, all extra costs for testing attributable to the delay will be back-charged to the Contractor and shall not be borne by the Owner.

1.11 Taking Specimens

A. Unless otherwise provided in the Contract Documents, all specimens and samples for tests will be taken by the testing laboratory or the Engineer.

1.12 Transporting Samples

A. The Contractor shall be responsible for transporting all samples, except those taken by testing laboratory personnel, to the testing laboratory.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. Temporary facilities required for this work include, but are not necessarily limited to:
 - 1. Temporary utilities such as water and electricity.
 - 2. First aid facilities.
 - 3. Sanitary facilities.
 - 4. Potable water.
 - 5. Temporary enclosures and construction facilities.
 - 6. Temporary Dewatering Facilities as specified herein and detailed further in Specification Section 01 51 43.

1.2 General

- A. First aid facilities, sanitary facilities and potable water shall be available on the Project site on the first day that any activities are conducted on site. The other facilities shall be provided as the schedule of the Project warrants.
- B. Maintenance: Use all means necessary to maintain temporary facilities in proper and safe condition throughout progress of the work. In the event of loss or damage, immediately make all repairs and replacements necessary, at no additional cost to the Owner.
- C. Removal: Remove all such temporary facilities and controls as rapidly as progress of the Work will permit.

1.3 Quality Assurance

- A. Temporary Electric: Installation of all temporary electric facilities shall comply with NECA, NEMA and UL standards and regulations for such facilities. Install service to comply with NFPA 70.

1.4 Temporary Utilities

- A. General
 - 1. Provide and pay all costs for all water, electricity and other utilities required for the performance of the work unless otherwise specified.
 - 2. Pay all costs for temporary utilities until Project completion.

Temporary Facilities and Controls

3. Costs for temporary utilities shall include all power, water and the like necessary for testing equipment as required by the Contract Documents.
4. Owner will make available potable water for the contractor's use at the following rates:
 - a. \$20.48 Base Charge per month, plus
 - b. \$0.2230/100 gallons for first 25,000 gallons per month
 - c. \$0.2725/100 gallons for next 50,000 gallons per month
 - d. \$0.3468/100 gallons over 75,000 gallons per month
5. Once permanent power has been connected to the Membrane Building, the Owner will assume responsibility for the cost of power within the building. Should there be more than two failures of the functional or operational tests of a particular unit or system, the Contract may be liable for the cost of power lost due to such failed tests.

B. Temporary Water

1. Connect to existing facility water system. Provide reduced pressure backflow prevention.
2. Provide all necessary temporary piping. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing, as necessary.
3. Upon completion of the Work, remove all such temporary piping.
4. Provide and remove water meters, as required by governing authority. Owner will furnish, and contractor shall install a compound meter for domestic potable water use.

C. Temporary Electricity

1. The Contractor shall provide its own generators or make arrangements for temporary power.
2. Provide all necessary wiring for the Contractor's use.
3. Provide main service disconnect and over-current protection at convenient location.
4. Furnish, locate and install area distribution boxes such that the individual trades may use their own construction type extension cords to obtain adequate power, and artificial lighting at all points where required by inspectors and for safety.
5. Existing receptacles may not be utilized during construction.

6. If existing site lighting is disabled during construction, provide and maintain temporary lighting to exterior work areas for routine plant operations.
 7. The Contractor shall set up account and pay all costs for electrical service.
- D. Temporary Ventilation
1. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors or gases. Provide temperature or humidity control, if required to meet required installation conditions.
- E. Temporary Heating
1. Provide temporary heating required by construction activities for curing or drying of completed installations or for protecting installed equipment.
- F. Temporary Sewer Facilities
1. Prior to starting the work, the Contractor shall furnish, for use of Contractor's personnel on the job, all necessary toilet facilities which shall be secluded from public observation.
 2. Existing sanitary facilities may not be used.
 3. All facilities, regardless of type, shall be kept in a clean and sanitary condition and shall comply with the requirements and regulations of the area in which the work is performed. Adequacy of these facilities will be subject to the Owner's review and maintenance of same must be satisfactory to the Owner at all times.

1.5 First Aid Facilities

- A. The Contractor shall provide a suitable first aid station, equipped with all facilities and medical supplies necessary to administer emergency first aid treatment. The Contractor shall have standing arrangements for the removal and hospital treatment of any injured person. All first aid facilities and emergency ambulance service shall be made available by the Contractor to the Owner and the Owner's personnel.

1.6 Potable Water

- A. The Contractor shall be responsible for furnishing a supply of potable drinking water for employees, subcontractors, inspectors, engineers and the Owner who are associated with the work.

1.7 Enclosures and Construction Facilities

- A. Furnish, install and maintain for the duration of construction, all required scaffolds, tarpaulins, canopies, steps, bridges, platforms and other temporary construction necessary for proper completion of the work in compliance with all pertinent safety and other regulations.

- B. All temporary enclosures and sheds located within construction areas or within 30 feet of existing building lines shall be noncombustible, in accordance with ASTM E136. Comply with NFPA 241.

1.8 Parking Facilities

- A. Arrange for temporary surface parking areas for the Contractor's and Contractor's subcontractors' personnel. Existing facilities provided by the Owner shall not be used for parking by the Contractor's or subcontractor's personnel.
 - 1. Designate three parking spaces for Engineer.
- B. When site space is not adequate, provide additional off-site parking.
- C. Maintain all roads, both temporary and permanent, in passable condition for all traffic. Any road blockage shall be coordinated with Engineer, Owner, and governing authorities.

1.9 Field Offices

- A. Contractor's Office: Weather-tight, with lighting, electrical outlets, heating and air conditioning equipment, sanitary facilities, and equipped with following items:
 - 1. Desks, 30"x60" – minimum two.
 - 2. Folding table, 30"x60".
 - 3. Chairs – minimum four.
 - 4. Photocopy machine.
 - 5. Waste Paper Receptacles.
 - 6. Compact refrigerator – minimum 4.3 cubic feet.
- B. Provide space for project meetings, with table and chairs to accommodate twelve persons.
- C. Contractor shall maintain field offices in good repair and acceptable appearance and shall provide weekly cleaning service and constant maintenance and replenishment, as applicable, of paper towels, paper cups, soap, toilet paper, and potable water supply. Failure to comply with the requirements of this paragraph may be cause for withholding of progress payments.

1.10 Removal

- A. Remove temporary above ground or buried utilities, materials, equipment, services, and construction prior to Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary facilities.

- C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. This Section covers furnishing, installing and maintaining a temporary dewatering system during construction. The system shall be operational from the moment the existing system is taken out of service until the new system is substantially complete and placed into operation by the Owner. The Contractor shall furnish all materials, labor, equipment, maintenance, etc., to put into operation a temporary dewatering system for the purpose of maintaining sludge dewatering at the existing Loopers Facility.

1.2 General

- A. The design, installation and maintenance of the temporary dewatering system shall be the Contractor's responsibility. The Contractor shall employ the services of a Specialty Contractor (Firm) who can demonstrate to the Engineer that it specializes in the design and operation of temporary dewatering systems. The Firm shall provide at least three references of projects of a similar size and complexity as this Project performed by his company within the past five years. The temporary system shall meet the requirements of all codes and regulatory agencies having jurisdiction.
- B. Refer to the Drawings for the proposed location for the temporary dewatering system and associated appurtenances. Owner's personnel will operate the equipment on a daily basis, but Contractor will be responsible for all maintenance and repairs required of the system provided. Thickened sludge will be pumped through existing sludge lines to the Sludge Prep Building using the existing WWTP sludge pumps. Contractor shall connect to the existing sludge lines in the Sludge Prep Building and provide flexible hose as required to convey the sludge to the centrifuge. Sludge loading system shall be capable of loading dewatered sludge into a standard truck with dump trailer. Owner will be responsible for transporting sludge from the site. Provide centrate return line to the Centrate Pump Station. Washwater shall also be returned to the Centrate Pump Station.
- C. Field Office: Provide a free-standing office trailer minimum size 8' x 12' for the Owner's personnel during operations. Office shall be weather-tight, with lighting, electrical outlets, heating and air conditioning equipment, sanitary facilities, and equipped with a desk, two swivel chairs and a four-drawer file cabinet.

1.3 Submittals

- A. The Contractor shall prepare with the Firm a specific, detailed description of the proposed system and submit it along with the Firm's references within 14 days following Notice to Proceed.

Temporary Dewatering Facilities

- B. The Contractor shall submit detailed plans and descriptions outlining all provisions for handling sludge and dewatered solids. This plan must be specific and complete, including such items as schedules, locations, elevations, capacities of equipment, materials and all other incidental items necessary and/or required to ensure proper protection of the facilities. The plan shall include but not be limited to details of the following:
1. Staging areas for dewatering equipment.
 2. Size, material, routing and method of installation of piping for sludge feed, centrate and washwater.
 3. Dewatering equipment capacity, and power requirements.
 4. Motor control package design, including wiring diagrams, voltage and amperage requirements, control logic description.
 5. Any temporary pipe supports and equipment anchoring required.
 6. Equipment to collect and load sludge into owner supplied trucks.
 7. Emergency and routine maintenance response plan.
 8. Erosion Control Plan.

Part 2 Products

2.1 Design and Performance Requirements

- A. Contractor to provide a complete sludge dewatering system consisting of one trailer-mounted centrifuge, polymer feed system, and solids conveyance.
- B. Dewatering equipment shall be adequately sized to for a minimum solids throughput of 1,500 dry lbs/hr.
- C. Aerobically digested feed sludge is normally between 1% to 3% solids. Minimum suspended solids recovery shall be 95%. Minimum sludge cake concentration shall be 18%. Maximum polymer use shall be 35 lbs active polymer per dry ton of solids produced.
- D. Sludge shall be fed to the temporary dewatering equipment using the Owner's existing variable speed progressing cavity pumps rated at 130 gallons per minute (gpm). The Contractor shall provide the necessary stop/start and variable speed control signals for each pump. The motor controls shall use a PLC based control system.
- E. Equipment will be operated by the Owner's staff on a 24-hour, 5-day per week basis. Normal operating schedule shall be Monday through Friday. Provide sufficient lighting for safe operation of the temporary facilities at night.

- F. The Firm shall perform all routine and emergency maintenance of the equipment.
- G. Contractor shall ensure adequate standby equipment is available. In the event of an emergency or breakdown standby equipment shall be mobilized to the site within 24 hours.
- H. The Contractor shall maintain a safe work environment for the operation staff and a system that will protect public and private property from damage.
- I. Upon completion of work the equipment shall be removed and the site shall be returned to its original condition.
- J. Temporary piping systems shall be constructed of restrained joint type piping systems that shall allow no leakage.

Part 3 Execution

3.1 Field Quality Control and Maintenance

- A. The Contractor shall perform leakage and pressure tests of the bypass pumping discharge piping prior to actual operation.
- B. The Contractor shall submit a plan for the replacement of malfunctioning equipment.
- C. Spare parts for shall be kept on site as required.

3.2 Installation and Operation

- A. The Contractor shall install the temporary facilities to minimize any disturbance to existing utilities and shall obtain approval of the pipeline locations from the Owner and the Engineer. Routing of overland pipelines shall not impede traffic flow.
- B. The Contractor shall protect the temporary facilities and piping from damage during construction.
- C. The Owner shall provide all power, polymer and water required for the temporary dewatering facility operation.

END OF SECTION

Part 1 General

1.1 Scope

- A. These general equipment stipulations apply, in general, to all equipment and piping. They supplement the detailed equipment Specifications, but in case of conflict, the detailed equipment Specifications shall govern.

1.2 Coordination

- A. The Contractor shall assume full responsibility for the coordination of the installation of all equipment, materials and products furnished under these Contract Documents. The Contractor shall be completely responsible for verification that all structures, piping and equipment components furnished by the Contractor and/or subcontractors and suppliers are compatible. The Contractor shall start-up each equipment system and shall make all necessary alterations. All such alterations shall be made at the Contractor's expense.

1.3 Unit Responsibility

- A. Equipment manufacturers assigned unit responsibility for systems comprised of several components shall be responsible for furnishing a complete system in accordance with the requirements of these Specifications. The manufacturer shall be responsible for all coordination between component manufacturers and shall provide all submittals, installation and start-up services and certifications on the system as a unit.

1.4 Adaptation and Location of Equipment

- A. No responsibility for alteration of a planned structure to accommodate other types of equipment will be assumed by the Owner. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All such alterations shall be made at the Contractor's expense.
- B. The Contractor shall install the work in such manner that the equipment, piping, vents, conduit, panels, ductwork and appurtenances be as neatly installed with adequate space for maintenance and passage of personnel.

1.5 Equipment Warranty

- A. The Contractor shall warrant all equipment against faulty or inadequate design, improper assembly or erection, defective materials, breakage or other failure. The Contractor's warranty period to Owner shall be defined in General Conditions of these Specifications. Unless stated otherwise in the individual specification sections, the warranty to be provided between the manufacturer/supplier and the Contractor shall be negotiated separately.

1.6 Workmanship and Materials

- A. All equipment shall be designed, fabricated and assembled in accordance with the most modern engineering and shop practice. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall be new and shall not have been in service at any time prior to delivery, except as required by tests.
- B. Materials shall be suitable for service conditions. Iron castings shall be tough, close grained, gray iron free from blowholes, flaws or excessive shrinkage and shall conform to ASTM A 48, Class 30 minimum. Plugging of defective castings shall not be permitted. Castings shall be annealed to remove internal stresses prior to machining and shall have the mark number and heat number cast on them.
- C. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject to shock or vibratory loads.
- D. All replaceable or expendable elements such as filters, screens, drive belts, fuses and lamps shall be easily accessible and replaceable without need of dismantling equipment or piping. All such items shall be of a standard type that is readily available from multiple suppliers.
- E. Threaded openings for drains or vents in pump volutes, compressor or fan scrolls, air receivers, and heat exchangers which are plugged during normal operation shall be provided with stainless steel plugs.
- F. All equipment delivered to the Project site shall include detailed installation instructions and a parts list.

1.7 Equipment Specifications

- A. The use of singular or plural terminology in the Specifications is not intended to define the number of units required to fulfill Contract requirements. Bidders must consult the Drawings and Specifications to determine how many units of a particular piece of equipment are required. This does not relieve the Contractor of the responsibility to provide all equipment specified when multiple units are specifically required in the Specifications.

1.8 Seal Water Requirements

- A. Where seal water is provided for flushing of mechanical shaft sleeves or sealing of shaft seal packing, provide equipment with drip pans fitted with drains to contain the leakage and convey it to the nearest suitable floor drain. Route drain piping to minimize obstructions to the movement of personnel.

1.9 Operating Fluids and Gases

- A. All operating fluids and gases recommended by the manufacturer and required for operation of the equipment shall be provided in sufficient quantity by the Contractor to fill all equipment and to replace all fluids and gases consumed during testing and start-up.

1.10 Lubrication and Lubrication Fittings

- A. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during start-up or shutdown and shall not waste lubricants.
- B. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity by the Contractor to fill all lubricant reservoirs and to replace all lubricants consumed during testing, start-up and initial operation. The Contractor shall provide sufficient quantities of lubricants to lubricate all equipment for one year of normal service before final acceptance of the equipment will be made by the Owner.
- C. Where special run-in oil or storage lubricants are used, they shall be flushed out and replaced with the required service lubricant by the Contractor.
- D. Tag each piece of equipment with a cloth tag showing proper type lubricant, period between lubrications, date of lubrication and worker's initials. Have space for 10 lubrication notations.
- E. Except for rotating shaft couplings, all lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings or guards. Fittings shall be accessible from safe, permanent platforms or walk areas. Fittings shall be of the bull-neck, check type for use with a portable high-pressure grease gun. Connection from a remote fitting to the point of use shall be with minimum 3/16-inch stainless steel tubing, securely mounted parallel to equipment lines and protected where exposed to damage.

1.11 Safety Guards

- A. All belt or chain drives, fan blades, couplings and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gauge or heavier galvanized or aluminum-clad sheet steel or 1/2-inch mesh galvanized expanded metal. Expanded metal safety guards shall be banded to eliminate sharp edges. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water. All safety guards shall comply with OSHA General Industry Standards, Part 1910, Subpart O, Machinery and Machine Guarding. Provide tachometer access on shaft ends.

1.12 Equipment Bases

- A. Where shown on the Drawings, equipment shall be installed on a raised, reinforced concrete base. The base shall be a minimum of 4-inches in height and shall extend beyond the equipment baseplate approximately 2-inches on all sides.
- B. The Engineer shall be consulted concerning electrical conduit locations prior to pouring the concrete base.
- C. Unless otherwise specified, a cast iron or welded steel baseplate shall be provided for each pump, compressor and any other item of equipment which is to be installed on a concrete base. Each unit and drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components and adequate grout holes. Baseplates for pumps shall have a raised lip all around and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with epoxy or non-shrink grout as specified in the grouting section.
- D. Centrifugal blower bases shall be installed in accordance with manufacturer's recommendations. Unless manufacturer instructions direct otherwise, blower bases shall be set on resilient pads and not hard bolted to the concrete pad. Where anchor bolts are utilized, threaded embedments or adhesive or expansion anchor studs shall be used with two nuts locked with a minimum 1/8-inch gap between nut and base frame.
- E. On direct coupled equipment, motor and driven equipment shall be doweled to a common base with a minimum of two dowels each.

1.13 Alignment of Motors and Equipment

- A. In every case where a drive motor is connected to a driven piece of equipment by a flexible coupling, the coupling halves shall be disconnected and the alignment between the motor and the equipment checked and corrected. Machinery shall first be properly aligned and leveled by means of steel wedges and shims or jacking screws near anchor bolts. Anchor bolts shall be tightened against the shims on wedges or jacking screws and the equipment shall again be checked for level and alignment before placing grout. Wedges shall not be placed between machined surfaces.
- B. In general, checking and correcting the alignment shall follow the procedures set up in the Standards of the Hydraulic Institute, Instructions for Installation, Operation, and Maintenance of Centrifugal Pumps. Equipment shall be properly leveled and brought into angular and parallel alignment.
- C. Equipment shall be installed in such a way that no strain is transmitted to the equipment by piping systems or adjacent equipment.
- D. Alignment shall be performed in the manufacturer's shop between drivers and driven equipment. After installation, a laser alignment shall be performed in the field by an independent testing laboratory acceptable to the Engineer and retained by the Contractor. The laser alignment shall be performed in the presence of a qualified manufacturer's field representative. The laser alignment system shall be either a

combined laser emitter and laser target detector or separate units for the emitter and detector.

- E. The driven equipment shall be operated under load for at least 90 minutes prior to performing the field alignment. Alignment tolerance values shall be as recommended by the driven equipment manufacturer or as specified in the equipment specification section. Alignment procedures shall comply with the equipment manufacturer's recommendations. Alignment shall be rechecked after equipment has operated under load for a minimum of 24 hours.
- F. Either shims or factory installed adjusting bolts shall be used to level the equipment and correct a soft foot condition.
- G. Shims shall meet the following Specifications:
 - 1. Commercially die-cut.
 - 2. Made of corrosion and crush resistant stainless steel, which is dimensionally stable when subjected to high compression over long periods of time.
 - 3. Consistent over the whole shim area, without seams or folds from bending.
 - 4. Clean, free from burrs, bumps, nicks, and dents of any kind.
 - 5. Size numbers or trademarks etched into the shim, not printed or stamped.
 - 6. The smallest commercial shim that will fit around the hold-down bolt without binding shall be used.
 - 7. The overall shim pack shall not exceed a total of three shims.
 - 8. Shims shall rest on bare metal, not paint or other coatings.
 - 9. Both driver and driven machines shall contain a minimum 0.125 inch shim (± 0.0003 inch) between all machine feet and mounting base, excluding alignment shims.
 - 10. All shims shall be selected from the proper size pre-cut series (A, B, C, D, etc.) to match the machine mounting bolt size and to maximize coverage of the machine footprint being supported. Multiple or oversized shims shall be used where the area of the machine footprint is 150 percent or greater than the proper size pre-cut series shim footprint.
- H. Both a shop and a field alignment report shall be submitted and shall contain the following information:
 - 1. Alignment tolerances used.
 - 2. Soft foot.
 - 3. Vertical angularity (pitch) at the coupling point.

4. Vertical offset at the coupling point.
5. Correct soft foot at all feet of both driver and driven machines. Actual allowable uncorrected soft foot measured at any machine foot shall be less than a maximum of 0.002 inch of required shim. This includes soft foot caused by angled foot or base conditions.
6. Horizontal angularity (yaw) at the coupling point.
7. Horizontal offset at the coupling point.

1.14 Grouting

- A. Special epoxy, non-shrink, or sand-cement grout shall be used in the placement of all pump, motor and equipment baseplates or bedplates, column baseplates, other miscellaneous baseplates and other grouting applications as shown on the Drawings.

1.15 Welding and Brazing

- A. All welds shall be sound and free from embedded scale and slag. All butt welds shall be continuous, and where exposed to view, shall be ground smooth. All continuous welds shall be gas and liquid-tight. Welds in piping shall have full penetration and shall be smooth on the inside of the pipe. Intermittent welds shall have an effective length of at least 2-inches and shall be spaced not more than 6-inches apart.
- B. All welding of steel and aluminum, including materials, welding techniques, general safety practices, appearance and quality of welds, and methods of correcting defective work, shall conform to the latest requirements of AWS Specifications. Structural steel welding shall conform to the requirements of the AWS Structural Welding Code. The general recommendations and requirements of the AWS Structural Welding Code shall also apply to welded aluminum structures. The welding process and welding operators shall meet qualification tests and welding performance tests in accordance with the latest provisions of ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications. Welding process and qualification procedures for welding of pipe shall conform to the latest requirements of ANSI B31.1, Section 327, Welding, and Section 328, Brazing and Soldering. All welding qualification tests shall be witnessed by the Engineer, except as provided herein. All costs associated with the qualification or testing of welders and welding operators shall be borne by the Contractor.
- C. Welding of stainless steels shall be performed by the MIG or TIG process, in accordance with ASME and AWS recommendations. After welding is completed, the welds shall be ground smooth, where required, and all welds shall be pickled and passivated such that the weld will be no less corrosion resistant than the base metal welded.
- D. Reports certifying that the welding procedures, welders and welding operators that the Contractor intends to use meet the requirements specified above. These reports shall be submitted to the Engineer prior to beginning the work. In the case of welder

qualifications for shop welding and for carbon steel field welding, welders presenting certified qualification papers validated within the preceding 6-month period will not be required to take the qualification tests. In the case of field welding of stainless steel or aluminum, all welders shall be required to take the qualification tests regardless of past experience or availability of certified qualification papers.

- E. Field welding practices shall conform to OSHA construction standards, Part 1926, Subpart J, Welding and Cutting. Shop welding practices shall conform to OSHA General Industry Standards, Part 1910, Subpart Q, Welding, Cutting, and Brazing.
- F. Welding electrodes for structural steel shall conform to the standard recommendations of the AISC. Welding electrodes for stainless steel shall conform to applicable AWS Specifications and shall be as recommended by "Welded Austenitic Chromium-Nickel Stainless Steels, Techniques and Properties", published by the International Nickel Company, New York, New York. Welding electrodes for aluminum shall conform to applicable AWS Specifications.
- G. Each welder and welding operator must identify all welds with welder's assigned symbol.
- H. Welders performing unsatisfactory work shall be removed from the welding process.
- I. The Owner may inspect any weld by radiographic or other means. Welds not in accordance with the requirements specified herein shall be repaired or replaced at the Contractor's expense. Excessive porosity, nonmetallic inclusions, lack of fusion, incomplete penetration and cracking shall constitute grounds for rejection of welds.

1.16 Erection and Setting

- A. In the erection and setting of all fabricated equipment, the Contractor shall exercise care to ensure that each item of equipment is adequately supported so as not to bend or distort under its own weight until adequate foundation support and anchorage are provided. Where lifting lugs, angles or clips are provided on equipment, they shall be used in erecting and setting the equipment. Erection and setting of equipment and structural steel shall conform to the requirements of OSHA Construction Standards, Part 1926, Subpart R, Steel Erection, Subpart H, Material Handling, Storage, Use, and Disposal, and Subpart N, Cranes, Derricks, Hoists, and Conveyors. Erection of structural steel shall conform to the latest requirements of the AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
- B. During placement and prior to any grouting or connection of adjacent piping, the equipment shall be leveled and aligned true to level, plumb, alignment and grade with all parts bearing or fitting the structure or equipment accurately and securely. It shall not be permitted to cock out of alignment, nor shall the Contractor redrill, reshape or force fit any fabricated items.
- C. The Contractor shall take all measurements necessary to properly fit Contractor's work in the field, and Contractor shall be governed by and responsible for these measurements and the proper working out of all details. The Contractor shall be responsible for the correct fitting of all work in the field and the accurate placement of all anchor bolts installed by Contractor.

- D. The Contractor shall bring all parts to be erected or assembled into close contact. Before assembly, all surfaces to be in contact with each other shall be thoroughly cleaned. Drift pins may be used only for bringing members into position, never to enlarge or distort holes. Torching or burning of holes or cutting of fabricated items to correct misalignment or shop errors shall not be permitted. Enlargement of holes necessary to make field connections shall be done only with the Engineer's approval by reaming with twist drills and in a manner acceptable to Engineer.
- E. All equipment shall be furnished with suitable eyebolt lifting lugs or lifting angles to facilitate handling.
- F. All flanged piping connections shall be "Two-Holed" such that the two upper-most flange bolt holes are horizontal.

1.17 Special Tools and Accessories

- A. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments and accessories required for proper maintenance. Special tools and accessories shall include those tools and accessories not normally available in an industrial hardware or mill supply house. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

1.18 Shop Priming and Painting

- A. All equipment shop priming and painting, including surface preparation, workmanship and materials, shall be as specified in Section 09 90 15 – Paint of these Specifications.

1.19 Field Priming

- A. All iron and carbon steel surfaces not specified to be galvanized or shop primed and all ferrous or nonferrous surfaces specified to be field primed and painted shall be coated in the field with one or more coats of primer.

1.20 Field Painting

- A. Except for interior surfaces of vessels and enclosed equipment not specified to be field painted, all ferrous and nonferrous surfaces of equipment which have received one or more coats of shop or field applied primer shall be field painted after installation in accordance with the requirements of Section 09 90 15 – Paint of these Specifications.

1.21 Galvanizing

- A. All galvanizing shall be done by the hot-dip process after fabrication in conformity with requirements of ASTM A 123, Grade 100; ASTM A 153, ASTM A 384 and ASTM A 385. Articles to be galvanized shall be pickled before galvanizing. Articles to be painted shall not be quenched.
- B. Where galvanized bolts are specified or required by the Drawings, zinc plated bolts will be acceptable provided zinc plating conforms to ASTM B 633, Type II.

- C. Areas of galvanizing damaged at the factory by welding or burning or otherwise damaged shall be thoroughly stripped and cleaned and recoated with zinc to the required thickness by the hot dip process. Areas of galvanizing damaged in the field during transportation, handling or installation shall be stripped, cleaned, and recoated with zinc to the required thickness in accordance with ASTM A 780, Annex A3.
- D. Galvanized articles shall be free from uncoated spots, blisters, flux, black spots, dross, projections and other defects not consistent with acceptable galvanizing practice.
- E. Zinc and cadmium plating shall be subject to visual examination to determine uniformity of coating. The Engineer may require that the coating uniformity be tested in accordance with ASTM A 239 or ASTM E 376.

1.22 Vibration Testing

- A. Unless specified otherwise in the Specifications, each pump or blower having a rated power of 50 HP, or greater, shall be tested in the field for acceptable vibration levels. Vibration testing shall be performed by an experienced, factory-trained and authorized vibration analysis expert (not a sales representative) retained by the Contractor for this work. Each unit shall be tested separately without duplicate equipment running. All field testing shall be done in the presence of the Engineer. The Engineer shall be furnished with four certified copies of vibration test data for each test performed. Motor site vibration tests shall be performed with all piping and appurtenances connected to the pump, but with the motor mechanically uncoupled from the pump. Vertical turbine pumps and motors shall be tested on-site, with readings taken at both the upper motor bearing housing and at the pump discharge head/motor pedestal top mounting plate. All tests specified below shall be performed and recorded at both locations for vertical turbine pumps. For constant speed systems, these vibration tests shall be performed with the pump coupled to the motor and at rated speed and flow.
- B. Where specified in the Specifications, equipment which is assembled and tested on the manufacturer's floor shall also be checked triaxially for vibration by the manufacturer. The results of these tests, along with location of vibration check points, shall be submitted to the Engineer. All readings shall be made on an X-Y recorder with appropriate scales indicated and an explanation thereon of any recordings exceeding specified limits. The field tests shall include substantiation of the manufacturer's test data.
- C. For systems with variable speed drives, tests shall be conducted at various speeds between maximum and minimum. For systems with two-speed drives, tests shall be conducted at both speeds. For systems with constant-speed drives, tests shall be conducted under various loading conditions as determined by the Engineer.
- D. Rotating equipment shall be tested for vibration in the field after installation by the following method. Equipment, complete with drive systems, in place at the job site, shall not vibrate more than the values allowed herein, unless otherwise specified in the detailed equipment specifications. All field tests shall be running tests with the equipment operating on the product for which it is intended or a substitute acceptable to the Engineer. The term displacement, as used herein, shall mean total peak-to-peak movement of vibrating equipment, in mils; velocity shall mean the peak velocity or speed of the vibrating equipment, in inches per second; acceleration shall

mean the maximum acceleration which occurs during the vibration cycle, measured in G's. Displacement and velocity shall be measured by a meter equal to IRD Mechanalysis Vibration Meter Model 306, or Bently-Nevada Model TK-8. Acceleration shall be measured by suitable equipment equal to IRD Mechanalysis, Bently-Nevada, subject to approval of the Engineer. Frequency of vibration, in cycles per minute (cpm), shall be determined when vibration exceeds specified levels or as otherwise necessary. Vibration shall be measured on the bearing housing, unless other locations are deemed necessary by the vibration analysis expert and Engineer.

- E. For all equipment tested, vibration shall be checked in the radial and axial directions. For pumps, vibration shall not exceed that permitted by the Hydraulic Institute.
- F. Critical speeds of all rotating equipment shall meet the following:
 - 1. For stiff shaft designs, the first critical speed of the rotating equipment shall be at least 25 percent above the maximum design operating speed.
 - 2. For flexible shaft designs, critical speeds shall be at least 2 percent above or below normal design operating speeds.
- G. The Contractor shall be responsible for unit and system assembly vibration testing and their results, which shall be within the specified limits. Copies of test results shall be submitted to the Engineer for review. Should the vibration field test results exceed shop test results or the limits specified herein, the Contractor shall correct the deficiencies within 30 days. After corrections have been completed, the vibration testing shall be rerun and the results resubmitted to the Engineer for review.

1.23 Hydraulic Systems

- A. All pipes, tubes and hoses for hydraulic fluid shall be securely restrained against movement.
- B. All hydraulic fluid reservoirs for hydraulic power packs shall be equipped with a low level shut-off mechanism which shall stop operation of the power pack when the level of fluid in the reservoir reaches a predetermined low level.
- C. All hydraulic systems shall be equipped with an alarm to notify the operator of system malfunction.

1.24 Noise Criteria

- A. Unless otherwise specified, noise levels for all operating equipment shall not exceed 90 dB at 5 feet from the equipment when measured on the A scale of a calibrated sound level meter at slow response.
- B. Noise criteria shall be met without the use of special external barriers or enclosures.

1.25 Identification of Piping and Equipment

- A. Equipment: All major items of equipment shall have an identification nameplate and dataplate.
1. Nameplates: The Contractor shall submit a suitable list of all items of major equipment to the Engineer, who will furnish the Contractor with an identification numbering system. The nameplates shall be of Type 304 stainless steel, No. 6 finish, and not less than No. 16 gauge with indented stamped lettering. Nameplates shall be attached to equipment bases in easily visible and accessible locations. Nameplates shall be fastened in a permanent manner, arranged not to damage the equipment, with not less than four stainless steel fasteners.
 2. Dataplates: Each item of mechanical equipment shall be provided with a stainless steel dataplate. Separate dataplates shall be provided for motors, engines and driven equipment. Dataplates shall include the following minimum information:
 - a. Name of equipment (from equipment specifications).
 - b. Manufacturer.
 - c. Model designation.
 - d. Serial number.
 - e. Rated horsepower.
 - f. Service factor.
 - g. Electrical and insulation data.
 - h. Speed (rpm).
 - i. Capacity and head (discharge pressure).
 - j. Net weight.
 - k. Lettering shall be upper case, block style in size and spacing to suit the nameplate. The identification nameplates shall not be painted.
- B. Valves: All valves shall be identified with a round stainless steel disc, approximately 1-1/2-inches in diameter and not less than No. 14 gauge, coated with a clear lacquer. Discs shall be fastened to valves in a permanent manner; attachment by chain to handwheels or other operators shall not be acceptable. Discs shall be stamped using indented numerals and/or letters with a valve number corresponding to its identification number in the valve schedule to be included in the operation and maintenance manual.

- C. All pushbutton stations, switches, motor controllers, transmitters and other control equipment shall have identification nameplates of the engraved, laminated plastic type affixed to or adjacent to the switch, pushbutton station, etc.
- D. All manufacturer's nameplates, identification nameplates and ASME code plates located on areas of equipment to be insulated shall be removed and reattached on uninsulated areas in a manner acceptable to the Engineer.

1.26 Safety Signs

- A. Permanent safety signs shall be furnished and installed on all mechanical and electrical equipment where a hazard may exist. Signs shall be made in accordance with current OSHA requirements and shall be suitable for exterior use. Mounting details shall be in accordance with manufacturer's recommendations; location in accordance with governing agency regulations. Fasteners shall be stainless steel.
- B. Safety signs shall be approximately 10-inches high by 14-inches wide, colored yellow and black on minimum 0.080-inch aluminum stock.
- C. Safety signs shall be furnished and will include, but not be limited to, the following:

- 1. The following sign shall be affixed to all equipment which may be started automatically from a remote location:

CAUTION
THIS EQUIPMENT MAY START AUTOMATICALLY BY REMOTE CONTROL

- 2. The following sign shall be affixed to all electrical equipment or instrument panels, as applicable:

CAUTION - SHOCK HAZARD
THIS EQUIPMENT IS POWERED BY MULTIPLE SOURCES
CONTACTS MAY BE ENERGIZED AFTER LOCAL POWER IS DISCONNECTED

- 3. The following sign shall be provided at all areas where oxygen or flammable materials are stored or used (colored red, white and black):

DANGER
NO SMOKING, MATCHES, OR OPEN FLAMES

- 4. The following sign shall be affixed to all entrance hatches or access manways on covered tanks and vessels:

CAUTION
OXYGEN DEFICIENT OR TOXIC CONDITIONS MAY EXIST
FOLLOW PRESCRIBED PROCEDURES BEFORE ENTRY

5. The following sign shall be provided at all compressor vents and equipment blowoffs:

CAUTION
LOUD BLOWDOWN MAY OCCUR WITHOUT WARNING

6. All chemical or hazardous material storage tanks containing flammable, toxic, reactive and otherwise unstable materials, or materials representing a personnel safety hazard shall be labeled in accordance with NFPA 704. Signage shall be applied to the tank exterior at all four architectural elevations (N, S, E & W) as well as the filling station. The NFPA signs shall have the color-coded diamonds and shall indicate the actual chemical name and emergency response info.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. The Contractor shall provide transportation of all equipment, materials and products furnished under these Contract Documents to the work site. In addition, the Contractor shall provide preparation for shipment, loading, unloading, handling and preparation for installation and all other work and incidental items necessary or convenient to the Contractor for the satisfactory prosecution and completion of the work.
- B. All equipment, materials and products damaged during transportation or handling shall be repaired or replaced by the Contractor at no additional cost to the Owner prior to being incorporated into the work.

1.2 Transportation

- A. All equipment shall be suitably boxed, crated or otherwise protected during transportation.
- B. Where equipment will be installed using existing cranes or hoisting equipment, the Contractor shall ensure that the weights of the assembled sections do not exceed the capacity of the cranes or hoisting equipment.
- C. Small items and appurtenances such as gauges, valves, switches, instruments and probes which could be damaged during shipment shall be removed from the equipment prior to shipment, packaged and shipped separately. All openings shall be plugged or sealed to prevent the entrance of water or dirt.

1.3 Handling

- A. All equipment, materials and products shall be carefully handled to prevent damage or excessive deflections during unloading or transportation.
- B. Lifting and handling drawings and instructions furnished by the manufacturer or supplier shall be strictly followed. Eyebolts or lifting lugs furnished on the equipment shall be used in handling the equipment. Spreader bars or lifting beams shall be used when the distance between lifting points exceeds that permitted by standard industry practice.
- C. Under no circumstances shall equipment or products such as pipe, structural steel, castings, reinforcement, lumber, piles, poles, etc., be thrown or rolled off of trucks onto the ground.
- D. Slings and chains shall be padded as required to prevent damage to protective coatings and finishes.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Product Storage and Handling Requirements

Part 1 General

1.1 Scope

- A. The work under this Section includes, but is not necessarily limited to, the furnishing of all labor, tools and materials necessary to properly store and protect all materials, equipment, products and the like, as necessary for the proper and complete performance of the work.

1.2 Storage and Protection

A. Storage

- 1. Maintain ample way for foot traffic at all times, except as otherwise approved by the Owner.
- 2. All property damaged by reason of storing of material shall be properly replaced at no additional cost to the Owner.
- 3. Packaged materials shall be delivered in original unopened containers and so stored until ready for use.
- 4. All materials shall meet the requirements of these Specifications at the time that they are used in the work.
- 5. Store products in accordance with manufacturer's recommendations.

B. Protection

- 1. Use all means necessary to protect the materials, equipment and products in accordance with manufacturer's recommendations of every section before, during and after installation and to protect the installed work and materials of all other trades.
- 2. All materials shall be delivered, stored and handled to prevent the inclusion of foreign materials and damage by water, breakage, vandalism or other causes.
- 3. Substantially constructed weather-tight storage sheds, with raised floors, shall be provided and maintained as may be required to adequately protect those materials and products stored on the site which may require protection from damage by the elements.

- C. Replacements: In the event of damage, immediately make all repairs and replacements necessary for the approval of the Owner and at no additional cost to the Owner.

- D. Equipment and products stored outdoors shall be supported above the ground on suitable wooden blocks or braces arranged to prevent excessive deflection or bending

between supports. Items such as pipe, structural steel and sheet construction products shall be stored with one end elevated to facilitate drainage.

- E. Unless otherwise permitted in writing by the Owner, building products and materials such as cement, grout, plaster, gypsumboard, particleboard, resilient flooring, acoustical tile, paneling, finish lumber, insulation, wiring, etc., shall be stored indoors in a dry location. Building products such as rough lumber, plywood, concrete block and structural tile may be stored outdoors under a properly secured waterproof covering.
- F. Tarps and other coverings shall be supported above the stored equipment or materials on wooden strips to provide ventilation under the cover and minimize condensation. Tarps and covers shall be arranged to prevent ponding of water.

1.3 Extended Storage

- A. In the event that certain items of major equipment such as air compressors, pumps and mechanical aerators have to be stored for an extended period of time, the Contractor shall provide satisfactory long-term storage facilities which are acceptable to the Owner. The Contractor shall provide all special packaging, protective coverings, protective coatings, power, nitrogen purge, desiccants, lubricants and exercising necessary or recommended by the manufacturer to properly maintain and protect the equipment during the period of extended storage.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. Construction staking shall include all of the surveying work required to layout the work and control the location of the finished Project. The Contractor shall have the full responsibility for constructing the Project to the correct horizontal and vertical alignment, as shown on the Drawings, as specified, or as ordered by the Engineer. The Contractor shall assume all costs associated with rectifying work constructed in the wrong location.
- B. From the information shown on the Drawings and the information to be provided as indicated under Project Conditions below, the Contractor shall:
 - 1. Be responsible for setting reference points and/or offsets, establishment of baselines, and all other layout, staking, and all other surveying required for the construction of the Project.
 - 2. Safeguard all reference points, stakes, grade marks, horizontal and vertical control points, and shall bear the cost of re-establishing same if disturbed.
 - 3. Stake out the permanent and temporary easements or the limits of construction to ensure that the work is not deviating from the indicated limits.
 - 4. Be responsible for all damage done to reference points, baselines, center lines and temporary bench marks, and shall be responsible for the cost of re-establishment of reference points, baselines, center lines and temporary bench marks as a result of the operations.
- C. Baselines shall be defined as the line to which the location of the work is referenced, i.e., edge of pavement, road centerline, property line, right-of-way or survey line.
- D. Record Drawing surveys shall be performed in accordance with Section 01 78 39 - Record Documents of these Specifications.

1.2 Project Conditions

- A. The Drawings provide the location and/or coordinates of principal components of the Project. The alignment of some components of the Project may be indicated in the Specifications. The Engineer may order changes to the location of some of the components of the Project or provide clarification to questions regarding the correct alignment.
- B. The survey points, control points, and baseline to be provided to the Contractor shall be limited to only that information which can be found on the Project site by the Contractor.

Construction Layout

- C. Additionally, the Engineer will provide the following:
 - 1. One vertical control point on the Project site with its elevation.
 - 2. A minimum of two horizontal control points on the Project site with their coordinates shown on the Drawings.

1.3 Quality Assurance

- A. The Contractor shall furnish documentation, prepared by a surveyor currently registered in the State in which the Project is located, confirming that staking is being done to the horizontal and vertical alignment shown in the Contract Documents. This requires that the Contractor hire, at the Contractor's own expense, a currently registered surveyor, acceptable to the Owner, to provide ongoing construction staking or confirmation of such.
- B. Any deviations from the Drawings shall be confirmed by the Engineer prior to construction of that portion of the Project.

1.4 Site Work

- A. Staking Precision: The precision of construction staking shall match the precision of a component's location indicated on the Drawings. Staking of utilities shall be done in accordance with generally accepted practice for the type of utility.

END OF SECTION

Part 1 General

1.1 Scope

- A. The work under this Section includes, but is not necessarily limited to, cutting and patching work as indicated on the Drawings, herein specified and as necessary for proper and complete performance of the work.
- B. Requirements for cutting and patching may be described in various sections of these Specifications.
- C. Execute cutting, including excavating and filling, or patching of work required to:
 - 1. Make several parts fit properly.
 - 2. Uncover work to provide for installation of ill-timed work.
 - 3. Remove and replace defective work.
 - 4. Remove and replace work not conforming to requirements of the Contract Documents.
 - 5. Remove samples of the installed work as specified for testing.
 - 6. Install specified work in existing construction.
- D. In addition, upon written instruction of the Engineer:
 - 1. Uncover work to provide for the Engineer's observation of covered work.
 - 2. Remove samples of the installed materials for testing.
 - 3. Remove work to provide for alteration of existing work.
- E. Protection of Work
 - 1. Do not endanger any work by cutting or altering the work or any part of it.
 - 2. Do not cut or alter the work of another contractor without written consent of the Engineer.

1.2 Submittals

- A. Prior to cutting which affects the structural safety of the Project or the work of another contractor, submit a written notice to the Engineer requesting consent to proceed with cutting. The notice shall include:

Cutting and Patching

1. Identification of Project.
 2. Description of defective work.
 3. Necessity for cutting.
 4. Effect on other work or on the structural integrity of the Project.
 5. Description of the proposed work including:
 - a. Scope of cutting and patching.
 - b. Subcontractor and trades to execute work.
 - c. Products proposed to be used.
 - d. Extent of refinishing.
 6. Alternatives to cutting and patching.
 7. Designation of party responsible for the cost of cutting and patching.
- B. Cost Estimate: Prior to cutting and patching performed on instruction of the Engineer, submit a cost estimate.
- C. Should conditions of the work or the schedule necessitate alternative materials or methods, submit a written recommendation to the Engineer that includes:
1. Compelling conditions for alternative materials or methods.
 2. Recommended alternative materials or methods.
 3. Submittals as required for substitutions.
- D. Uncovered Work: Submit written notice to the Engineer designating the time the work will be uncovered for the Engineer's observation.

1.3 Payment for Cost

- A. Contractor's Costs: Costs caused by ill-timed or defective work or work not conforming to the Contract Documents, including costs for additional services of the Engineer, shall be paid by the Contractor.
- B. Owner's Costs: Cost of work done as the result of the Engineer's/Owner's instructions, which is not shown on the Drawings or specified, other than defective or non-conforming work, will be paid for by the Owner.

Part 2 Products

2.1 Materials

- A. All products and materials shall conform to the requirements of the Specifications for the type of work being performed, except where no products are specified in these Specifications for the item being replaced; then the products and materials shall be of an equivalent type, quality, thickness and width of the item removed.

Part 3 Execution

3.1 Inspection

- A. Inspect existing conditions of the work including elements subject to movement or damage during cutting and patching or excavating and backfilling.
- B. After uncovering work, inspect conditions affecting the installation of new products.

3.2 Preparation

- A. Provide shoring, bracing and support as required to maintain structural integrity of the Project.
- B. Provide protection for other portions of the Project and provide protection from the elements.

3.3 Performance

- A. Execute fitting and adjustments of products to provide finished installation that complies with specified tolerances and finishes.
- B. Execute cutting and demolition by means that will prevent damage to other work and will provide proper surfaces to receive installation of repairs and new work.
- C. Restore work which has been cut or removed and install new products to provide completed work in accordance with the requirements of the Contract Documents.
- D. Refinish entire surfaces as necessary to provide an even finish. Continuous surfaces shall be refinished to the nearest intersection and assemblies shall be entirely refinished.

END OF SECTION

Part 1 General

1.1 Work Included

- A. Section includes requirements for cleanup, re-stabilization, restoration, and disposal to maintain a safe and well-kept job site and properly repair disturbed areas.

1.2 Quality Assurance

- A. Daily, and more often if necessary, conduct inspections verifying that requirements of cleanliness are being met.
- B. In addition to the standards described in this Section, comply with all pertinent requirements of governmental agencies having jurisdiction.

1.3 Cleaning Materials and Equipment

- A. Provide all required personnel, equipment and materials needed to maintain the specified standard of cleanliness.
- B. Use only the cleaning materials, methods and equipment which are compatible with the surface being cleaned, as recommended by the manufacturer of the material or as approved by the Engineer.

1.4 Cleaning During Construction

- A. (For Interior Areas) Proceed with construction cleanup concurrently with construction progress.
 - 1. Remove mud, oil, grease, soil, gravel, trash, scrap, debris, and excess materials that are unsightly or may cause accidents to persons or properties.
 - 2. Remove water from floor areas where electrical power tools are to be used and prevent stains on concrete that will be exposed in finish work.
 - 3. Select and employ cleaning materials and equipment with care to avoid scratching, marring, defacing, staining, or discoloring surfaces cleaned.
- B. (For Exterior Areas) Throughout all phases of construction, including suspension of work, and until the Final Acceptance, the Contractor shall keep the site clean and free from rubbish and debris. The Contractor shall also abate dust nuisance by cleaning, sweeping and sprinkling with water, or other means as necessary. The

use of water resulting in mud on driveways, parking lots or streets will not be permitted as a substitute for sweeping or other methods.

1. The road(s) on the construction site shall be paved immediately after the installation of underground utilities and the construction and underground/final inspection of storm drainage, curbs, and gutters. The exit road on the construction site shall be paved first.
 2. Vehicles exiting the construction site shall have all dirt clods and mud removed from their tires.
 3. Materials and equipment shall be removed from the site as soon as they are no longer necessary. Before the final inspection, the site shall be cleared of equipment, unused materials and rubbish so as to present a satisfactory clean and neat appearance. All cleanup costs shall be included in the Contractor's Bid.
 4. Care shall be taken to prevent spillage on haul routes. Any such spillage shall be removed immediately, and the area cleaned.
 5. Excess excavated material from catch basins or similar structures shall be removed from the site immediately. Sufficient material may remain for use as backfill if permitted by the Specifications. Forms and form lumber shall be removed from the site as soon as practicable after stripping.
- C. Failure of the Contractor to comply with the Engineer's cleanup orders may result in an order to suspend work until the condition is corrected. No additional compensation will be allowed as a result of such suspension.

1.5 Final Cleaning

- A. Upon completion of the work, the Contractor shall remove from the site all plant, materials, tools and equipment belonging to him, and leave the site with an appearance acceptable to the Owner.
- B. Thoroughly clean all equipment and materials installed and deliver over such materials and equipment in a bright, clean, polished and new appearing condition.
- C. Restore or replace all landscape features scarred or damaged by the Contractor's equipment or operations as nearly as possible to original condition, at the Contractor's expense. The Owner will approve the method of restoration to be used.
- D. The Contractor shall remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, or any other vestiges of construction, as directed by the Owner. It is anticipated that excavation, filling and plowing of roadways will be

required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The restored areas shall be filled, graded, and spread with sufficient topsoil to provide a minimum depth of four inches of suitable soil for the growth of grass, and the entire area shall be seeded or sodded with the original type of grass. Areas shall be restored to original contours as shown on the Plans. If the Plans do not cover the specific areas to be restored, the areas shall be graded to drain and give a smooth transition to the surroundings.

1.6 Measurement and Payment

- A. No separate payment will be made for any items of work, materials, parts, equipment, supplies, or related items required to perform and complete the requirements of this section. The costs for all such items required shall be considered subsidiary to other items of this Contract and shall not be paid for separately.

1.7 Disposal of Waste

- A. The definitions contained in Georgia Environmental Protection Division Rules 391-3-4-.01 shall be applicable to this Project. The term waste shall include excess and surplus materials and shall include liquid and solid wastes.
- B. Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
- C. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
- D. Remove and transport waste in a manner that will prevent spillage on adjacent surfaces and areas.
- E. Burning: Do not burn waste materials on site.
- F. Waste removed from the Project site shall be disposed of in sites permitted by the Georgia Environmental Protection Division for the acceptance of type of waste being disposed. The acceptable types of permitted disposal facilities are as follows:
 - 1. Inert Waste Landfills.
 - 2. Municipal Solid Waste Landfills.
 - 3. Municipal Solid Waste Landfills permitted to receive only construction and demolition wastes.

G. Exceptions to Paragraph F are as follows:

1. Hazardous waste shall be disposed of in accordance with Georgia Environmental Protection Division Rules 391-3-11.
2. Asbestos-containing waste shall also be handled and disposed of in accordance with Georgia Environmental Protection Division Rules 391-3-14.
3. Excess earth material and excess excavated rock material may be placed on sites for which the Contractor provides to the Owner a signed affidavit from the property owner that the placement of such material is acceptable to the property owner. The Contractor and property owner shall be responsible for all permitting of such disposal.

H. No waste shall be placed at a transfer station facility.

I. The Contractor shall maintain records related to all waste removed from the Project site so as to allow the Owner or the Engineer to readily determine the following:

1. Date waste removed from Project site.
2. Name of hauler (company and driver) transporting such waste.
3. General description of waste transported.
4. "Truck tickets" indicating the waste disposal site and amount of waste disposed therein.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. The work under this Section includes, but is not necessarily limited to, the provision of all labor and material required to perform installation inspection and start-up of all equipment and mechanical systems installed under this Contract.
- B. The work defined under this Section includes providing the services of a trained factory representative in accordance with the requirements of Section 01 43 33 of these Specifications.
- C. Certification of start-up and full testing shall be performed by the manufacturer using the services of a factory representative trained in this type service.
- D. Unless otherwise specified, the Contractor shall furnish all labor, materials, water, air, oil, power, fuel, chemicals, test equipment and other items required to conduct the field tests, including any retests.
- E. The cost of all field testing shall be included in the Contract Price and no separate payment will be made.
- F. The Owner will furnish at no cost chemicals for the Contractor's use which are to be consumed for the treatment operations, including such needed for testing, startup and initial filling of chemical vessels. Contractor shall perform all labor and handling in the use of such chemicals. Should there be more than two failures of the functional or operational tests of a particular unit or system, the Contractor may be liable for the cost of chemicals lost due to such failed tests. The Owner will not furnish any chemicals associated with the cleaning and disposal of the membrane shipping and storage fluids.

1.2 Coordination

- A. The Contractor shall not proceed with any functional test or operating test until the operation and maintenance manuals for the equipment have been submitted and been designated "No Exceptions Taken". The Contractor shall coordinate all activities required for starting of systems including the visits by the factory representatives, particularly where an equipment item's operation is dependent on the operation of other equipment. Prior to calling the factory representative, the Contractor shall ensure that all necessary related equipment, structures, piping and electrical work is complete. Any required revisits to the site by the factory representative shall be provided by the Contractor.

1.3 Pre-Start-Up Maintenance

- A. After installation and prior to start-up, all grease-lubricated joints, shaft couplings and bearings shall be flushed out and re-greased. All oil reservoirs and sumps shall be completely drained and flushed and refilled with the proper lubricant. All operating fluid and gas reservoirs shall be filled with the proper fluid and gases. Screens and filters

shall be checked for contamination and replaced if necessary. Belt drives shall be checked, and tension adjusted, as needed. The equipment shall then be tagged, signed and dated, indicating that the equipment has been properly lubricated and prepared for start-up.

1.4 Installation Inspection

- A. Prior to energizing any piece of equipment or performing a functional test, a factory representative of the equipment manufacturer shall inspect the installation of the equipment. The factory representative shall determine if the equipment has been installed in accordance with the manufacturer's recommendations, pre-start-up maintenance has been performed, and is ready for start-up and the initiation of the functional test.
- B. Should the installation inspection indicate that the equipment has been improperly installed or prepared for start-up, the Contractor shall provide such modifications or adjustments as required for the equipment to operate properly.
- C. The factory representative shall certify that the equipment has been installed in accordance with the Drawings, Specifications, and the manufacturer's recommendations and that the equipment is ready for start-up and functional testing to be performed.

1.5 Functional Test

- A. Following the installation inspection by factory representative, perform a functional test on each piece of equipment. The functional test shall consist of operation of the equipment on a normal duty cycle for a sufficient period of time to determine satisfactory operation. Time required for functional testing shall be as specified in the equipment specifications or a minimum one continuous eight-hour period, whichever is longer. To the maximum extent practical, exercise the full capabilities of all equipment including remote operation, instrumented control schemes, alternate modes of operation and emergency operation. Equipment shall be checked for any abnormal noise or vibration as part of the functional test, and any observed abnormal conditions corrected prior to certification.
- B. Should the results of the functional test indicate that the equipment has failed to perform in accordance with the Specifications, the Contractor shall make, at no additional cost to the Owner, all modifications or adjustments as required for satisfactory operation, including replacement of any or all components, if necessary. Following the modifications or adjustments, the Contractor shall repeat the functional test. This procedure shall be repeated until the results of the test indicate that the equipment has satisfied the requirements of the applicable Specification Section.
- C. After the functional test is completed, each manufacturer shall certify, in writing, that tests were made in accordance with the Specifications and the manufacturer's recommendations, that the functional tests and start-up operation have been satisfactory, and that the equipment is fully operational and capable of meeting operating requirements.

1.6 Operating Test Period

- A. Following the functional test, the Contractor shall place each system into service and undergo an operational test under normal service conditions. The minimum time for the operating test period for each system shall be 30 consecutive days, excluding time that the equipment is taken out of service.
- B. Where required in the equipment specifications, process performance testing shall be performed during the operating test period in accordance with the requirements of the equipment specifications. The Contractor shall provide all materials and labor, including the services of a factory representative, necessary to perform the performance testing.
- C. The test period shall commence upon the initiation of operation of all systems and shall end after the successful operation of the equipment for the minimum time required.
- D. The Contractor shall repair and make all modifications required due to mechanical failure of the equipment during the operating test period. Should the equipment fail to meet the performance testing requirements, a factory representative shall evaluate the equipment and determine the cause of the process failure. The Contractor shall make all modifications recommended by the manufacturer.

1.7 Certification

- A. Upon completion of start up, the Contractor shall provide written Installation and Start-Up Report from all equipment manufacturers' factory representatives. Report shall address the equipment installation's compliance with manufacturer's requirements and note any problems noted that may affect the warranty, operation or longevity of the equipment. Written certification shall indicate that tests were made in accordance with the manufacturer's recommendations, that the test and start-up operation has been satisfactory completed and that the equipment is fully operational under design requirements. Written certification shall be filed with the Engineer on the manufacturer's stationary.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

Manufacturer's Installation and Start-up Report

GENERAL INFORMATION:

Owner: _____ Contractor: _____
 Facility: _____ System: _____
 Location: _____ Specification Number: _____
 Tag: _____

MANUFACTURER:

Manufacturer Name: _____
 Address: _____
 City/State/Zip: _____
 Phone Number: _____ Fax Number: _____
 E-Mail: _____
 Manufacturer's Representative: _____

1. Required safety equipment available?	Y ☐	N ☐	N/A ☐
2. Are equipment tags correct and attached to equipment?	Y ☐	N ☐	N/A ☐
3. Are rotating equipment safety guards in place and secure?	Y ☐	N ☐	N/A ☐
4. Shaft and couplings aligned?	Y ☐	N ☐	N/A ☐
5. Have belt drives been aligned?	Y ☐	N ☐	N/A ☐
6. Bearings lubricated?	Y ☐	N ☐	N/A ☐
7. Oil reservoirs filled with proper lubricant?	Y ☐	N ☐	N/A ☐
8. Rotation verified?	Y ☐	N ☐	N/A ☐
9. Is equipment level?	Y ☐	N ☐	N/A ☐
10. Equipment anchored properly?	Y ☐	N ☐	N/A ☐
11. Equipment grouted properly?	Y ☐	N ☐	N/A ☐
12. Required utilities available?	Y ☐	N ☐	N/A ☐
13. Nozzles free from loads?	Y ☐	N ☐	N/A ☐
14. Are required pressure and temperature	Y ☐	N ☐	N/A ☐
gauges and sensors installed?	Y ☐	N ☐	N/A ☐
15. Have any shipping coatings/sealants been removed?	Y ☐	N ☐	N/A ☐
16. Does any paint/coating damage need to be repaired?	Y ☐	N ☐	N/A ☐
17. Have moving parts been checked for proper running clearance?	Y ☐	N ☐	N/A ☐
18. Is there any observed leakage of lubricants	Y ☐	N ☐	N/A ☐
or fluids from equipment?	Y ☐	N ☐	N/A ☐
19. Are all electrical power connections made and properly torqued?	Y ☐	N ☐	N/A ☐
20. Are electrical overloads properly set?	Y ☐	N ☐	N/A ☐
21. Are current transformers properly wired for polarity?	Y ☐	N ☐	N/A ☐
22. Are control enclosures per the specified NEMA	Y ☐	N ☐	N/A ☐
classification and material?	Y ☐	N ☐	N/A ☐

Startup Procedures

23. Are instrumentation connections terminated?	Y ☐	N ☐	N/A ☐
24. Are signal cable shield leads grounded in accordance with Manufacturer's recommendations?	Y ☐	N ☐	N/A ☐
25. Are required spare parts on-site, inventoried and properly stored?	Y ☐	N ☐	N/A ☐
26. Are Operations and Maintenance Manuals on-site and complete?	Y ☐	N ☐	N/A ☐
27. Are all installation requirements of the O&M Manuals performed?	Y ☐	N ☐	N/A ☐
28. Does equipment have a record of maintenance and exercise as recommended by the manufacturer during storage?	Y ☐	N ☐	N/A ☐
29. Are there any observed installation issues that impact the equipment warranty?	Y ☐	N ☐	N/A ☐

Additional items noted during installation inspection by Manufacturer's Start-up Representative:

I certify as an authorized Factory Representative, that the equipment is installed in accordance with the Manufacturer's recommendations and is ready for start-up and initial operation.

Factory Representative: _____

Representing: _____

Mailing Address: _____

Phone Number: _____

E-mail Address: _____

Date: _____
(If employed by other than the Manufacturer)

Startup Procedures

START-UP REPORT:

1. Does equipment operate and perform in accordance with the specification?	Y ☐	N ☐	N/A ☐
2. Have all specified modes of operation been tested and verified?	Y ☐	N ☐	N/A ☐
3. Do all system indicators, readouts, controls and operator interfaces operate?	Y ☐	N ☐	N/A ☐
4. Have variable speed units been tested throughout the available speed range?	Y ☐	N ☐	N/A ☐
5. Have multi-speed motors been tested on all available speeds?	Y ☐	N ☐	N/A ☐
6. Did equipment exhibit any abnormal vibration during operation?	Y ☐	N ☐	N/A ☐
7. Did equipment exhibit any abnormal noise during operation?	Y ☐	N ☐	N/A ☐
8. Are bearings operating at normal temperature?	Y ☐	N ☐	N/A ☐
9. Do bearings display any roughness in operation?	Y ☐	N ☐	N/A ☐
10. Prior to start-up, or during initial operation, was any leakage of lubricant observed?	Y ☐	N ☐	N/A ☐
11. Was any leakage of process fluids observed during start-up?	Y ☐	N ☐	N/A ☐
12. Has operation of equipment protective systems been verified?	Y ☐	N ☐	N/A ☐
13. Is the equipment ready to place into operation?	Y ☐	N ☐	N/A ☐

Additional items noted during start-up by Manufacturer's Start-up Representative:

I certify as an authorized Factory Representative, that the equipment has been properly started up in accordance with the Manufacturer's recommendations and is ready for initial operation.

Factory Representative: _____

Date: _____

END OF SECTION

Part 1 General

1.1 Scope

- A. The Contractor shall provide five copies of a complete and comprehensive reference manual (Operating and Maintenance Manual) containing operating and maintenance data to enable operators and plant engineers to correctly operate, service and maintain all equipment and accessories covered by the Specifications and Drawings. The data contained in the manual shall explain and illustrate clearly and simply all principles and theory of operation, operating instructions, maintenance procedures, calibration procedures and safety precautions and procedures for the equipment involved.
- B. No separate payment will be made for the Operating and Maintenance Manual and the cost of said manual shall be included in the Contract Price.

1.2 Submittal Schedule

- A. The Contractor shall submit, for the Engineer's approval, three preliminary drafts of proposed formats and outlines of contents of manuals within 60 calendar days after the Notice to Proceed. The Engineer will notify the Contractor, in writing, of any deficiencies in the manual and will return one copy of the manual for completion and/or correction.
- B. Submit three preliminary copies of manuals before the work covered by the Contract Documents is 40 percent complete. The Contractor must also submit three copies of the manual in digital format as specified below. The Engineer will notify the Contractor, in writing, of any deficiencies in the manual and will return one copy of the manual for completion and/or correction.
- C. Resubmissions: Clearly identify each correction or change made. The resubmission shall be accompanied by a letter listing all comments made by the Engineer and the actions or response by the manufacturer or vendor to each comment. Where the Engineers comment applies to multiple areas of the initial submittal the response shall address all areas. The response letter shall also address where supplemental information has been provided and where it is located within the resubmission.
- D. Before the work covered by the Contract Documents is 70 percent complete, the Contractor must submit six final copies of the revised and completed manual, complete in detail as specified below. The Contractor must also submit five copies of the manual in digital format as specified below.
- E. Digital Copies of Manuals: Operations and Maintenance Manuals shall be provided by the Contractor in digital format concurrently with both the preliminary and final hard copy submissions. Materials available in digital format shall be furnished in accordance with the following:
 - 1. All textual data shall be provided as an electronic file in searchable Adobe Acrobat Portable Document Format (PDF). The PDF file(s) shall be fully indexed using the Table of Contents, searchable with thumbnails generated. File(s) shall be identified by utilization of a "twelve dot three" convention

(XXXXXX.XX.YY.pdf) where X is the eight digit number corresponding to the specification section, and YY is an identification number. All documents shall be scanned at 300dpi or greater utilizing optical character recognition (OCR) software. All text in the document must be text selectable with the exception of pages which are in their entirety drawings or diagrams. Word searches of the PDF document must function successfully. PDF files that fail to comply with the indexing and searchable features described above will not be acceptable. All drawing data shall be provided in digital format compatible with AutoCAD Version as designated by the Engineer.

2. Materials not available in original digital format (available only in paper format) shall be scanned as noted above into a PDF format and cleaned to remove smudges, fingerprints, artifacts, and other extraneous marks. All notes, version stamps, etc. shall be preserved. Color maps shall be scanned in not less than the number of colors of the document or 16 colors, whichever is greater. Color photographs shall be saved in not less than 256 colors. Black and white or monochrome scans (non-text) shall not be less than 16 gray scale levels. Color maps, color photographs, and black and white and gray scale photograph files shall be saved as GIF or JPG files, compatible with Adobe Photoshop Version 4.0. Documents shall be scanned in the existing color format of the document, i.e. color documents shall be scanned in color, and black and white or monochrome in gray scale.
3. After the documents are in correct digital format, they shall be furnished to the Engineer as a 120 mm, 680mb, 74-minute CD ROM. All media transmittals shall be accompanied by a detailed paper printout of the files on the media. This printout shall consist of a file name, file size, date of creation, submittal number, and a brief but accurate description of the file. Files shall not be transmitted electronically. Five copies of the CD for each Operation and Maintenance Manual shall be provided to the Engineer.

1.3 Submittal Format

- A. Each hard copy of the manual shall be assembled in one or more loose leaf binders, each with title page, typed table of contents, typed list of tables, typed list of figures, and heavy section dividers with reinforced holes and numbered plastic index tabs. Binders shall be uniform for all manuals and shall be 3-ring, hardback type, with transparent vinyl pocket front cover suitable for inserting identifying cover and with a transparent vinyl pocket on the spine for label. All data shall be punched for binding. Composition and printing shall be arranged so that punching does not obliterate any data. The cover and binding edge of each manual shall have the project title, specification section number and title, and manual title printed thereon, all as approved by the Engineer.
- B. All copies of shop drawings, figures and diagrams shall be reduced to either 8-1/2 x 11-inches or to 11-inches in the vertical dimension and as near as practical to 17-inches in the horizontal dimensions. Such sheets shall be folded to 8-1/2 x 11-inches. The manual and other data shall be printed on first quality paper, 8-1/2 x 11-inch size with standard 3-hole punching. Binders shall be labeled Vol. 1 of "X", Vol. 2 of "X", etc., where "X" is the total number of volumes in the set where more

than one is required. The table of contents for the entire set, identified by volume number, shall appear in each binder. Text, figures and drawings shall be clearly legible and suitable for dry process reproductions.

- C. Each submittal shall have a cover sheet that includes the following information:
 - 1. The date of submittal and the dates of any previous submittals.
 - 2. The Project title.
 - 3. Submittal numbering shall be in accordance with Section 01 33 00 of these Specifications.
 - 4. The names of:
 - a. Contractor.
 - b. Supplier.
 - c. Manufacturer.
 - 5. Identification of the product, with the Specification section number, permanent equipment tag numbers and applicable Drawing No.
- D. The Engineer will not recommend final acceptance of the Work until the Operating and Maintenance Manual is complete and satisfactory to Engineer.

1.4 Contents of Operating and Maintenance Manual

- A. Each manual shall include a title page which includes all information specified in Article 1.3, paragraph C of this Section. In addition, the title page shall include manufacturer's address, phone number, facsimile number, and contact; manufacturer's equipment name and model number; supplier's address, phone number, facsimile number, and contact.
- B. Each manual shall include a table of contents identifying the location of each item listed below, for each component supplied. For items not applicable to a component, the table of contents shall list N/A for the page number.
- C. For all equipment, the Contractor shall furnish a complete, detailed listing of all equipment, components and accessories showing component name, manufacturer, model number and quantity information shall be furnished for each component as outlined below:
 - 1. A summary page shall be provided for each piece of equipment detailing the following information:
 - a. Equipment Number.
 - b. Equipment Description.

- c. Serial Number.
 - d. Model Number.
 - e. Manufacturer.
 - i. Address.
 - ii. Phone.
 - iii. Representative.
 - f. Supplier.
 - i. Address.
 - ii. Phone.
 - iii. Representative.
 - g. Local Service Provider.
 - i. Address.
 - ii. Phone.
 - iii. Representative.
 - h. Location of Equipment.
 - i. Equipment Design Criteria.
 - i. HP.
 - ii. Flow Rate, etc.
 - j. Performance Data.
 - k. Normal Operating Characteristics.
 - l. Limiting Conditions.
2. Detailed disassembly, overhaul and reassembly, installation, alignment, adjustment and checking instructions.
 3. Detailed operating instructions for start-up, calibration, routine and normal operation, regulation and control, safety, shutdown and emergency conditions. Detailed list of settings for relays, pressure switches, temperature switches, level switches, thermostats, alarms, relief valves, rupture discs, etc.

4. Detailed preventative maintenance procedures and schedules, including detailed lubrication instructions and schedules, identification of required lubricants and operating fluids (description, specification and trade name of at least two manufacturers), and diagrams illustrating lubrication points.
5. Detailed guide to equipment and/or process "troubleshooting".
6. Detailed parts lists identified by title, materials of construction, manufacturer's part number, list of recommended spare parts identified as specified above, current cost list for recommended spare parts, predicted life of parts subject to wear, and an exploded or concise cut-away view of each equipment assembly. The manufacturer's part numbers must match those used for the spare parts, documentation, identification, and turn-over. Should no spare parts be required, state in the Table of Contents that "No spare parts are required".
7. Electrical and instrumentation schematics, including motor control centers, control panels, wiring diagrams, instrument panels and analyzer panels. All panels must have as-built schematics inside them at contract close-out.
8. List of all special tools supplied and description of their use. Special tools include any tool not normally available in an industrial hardware or mill supply house. Should no special tools be required, state in the Table of Contents that "No special tools are required".
9. List of names and addresses of nearest service centers for parts, overhaul and service.
10. Procedures for storing, handling and disposing of any chemicals or products used with the equipment or system.
11. For equipment and systems, also provide the following:
 - a. Control and wiring diagrams provided by the controls manufacturer.
 - b. Sequence of operations by the controls manufacturer.
 - c. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
12. The supplier's operation and maintenance information will address the particular equipment furnished, with specific details on operation and maintenance practices. General data is not acceptable. Information contained in the manual which is not appropriate to the Project shall be marked out and noted as "N/A".

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

SAMPLE COVER PAGE

COMPLETE PROJECT TITLE

LOCATION OF PROJECT

OPERATING and MAINTENANCE DATA

FOR SUBMITTAL NUMBER (AS LISTED IN PCM)

TITLE OF SUBMITTAL

CONTRACTOR: (Name only Required)

SUPPLIER: (Name only required)

MANUFACTURER: (Name only Required)

SPECIFICATION SECTION:

EQUIPMENT TAG NUMBER:

DRAWING NUMBER:

DATE OF SUBMISSION

SAMPLE TITLE PAGE

COMPLETE PROJECT TITLE

LOCATION OF PROJECT

OPERATING and MAINTENANCE DATA

FOR SUBMITTAL NUMBER (AS LISTED IN PCM)

TITLE OF SUBMITTAL

CONTRACTOR: (Complete Information Required)

SUPPLIER: (Complete Information Required)

MANUFACTURER: (Complete Information Required)

SPECIFICATION SECTION:

EQUIPMENT TAG NUMBER:

DRAWING NUMBER:

DATE OF SUBMISSION

SAMPLE MANUAL REVIEW CHECK LIST**FINAL COPIES / PRELIMINARY COPIES
OPERATION AND MAINTENANCE MANUAL CHECK LIST****PROJECT NUMBER:****PROJECT NAME:****SECTION:****SECTION Requirements**

- 1.03 - A ____ 3 ring loose leaf binder with transparent covers on binder and cover
- 1.03 - A ____ Title Page, Table of Contents, Section dividers and List of tables & figures
- 1.03 - B ____ Drawings and figures shall be legible and 11" in the vertical dimension
- 1.03 - C ____ Cover Page including: Date of Submittal & any previous submissions, Project & Manual Title, Names of Contractor, Supplier, Manufacturer, Spec. Section, Equip. Tag Number & Drawing No
- 1.04 - A ____ Title Page: All cover page information & manufacturers and suppliers address, phone & fax number and contact person; manufacturer's equipment name and model number
- 1.04 - B ____ Table of Contents identifying the location of each item listed
- 1.04 - C.1 ____ Provide equipment function, operating char., performance data, limiting cond. and pump curves
- 1.04 - C.2 ____ Detailed: disassembly, overhaul, reassemble, installation, alignment, adjusting & checking Instructions
- 1.04 - C.3 ____ Operating instructions for start up, calibration, normal operation, shutdown, etc.
- 1.04 - C.3 ____ List of settings for relays, pressure switch, temperature switch, level switch and alarms
- 1.04 - C.4 ____ Preventive maintenance procedures and diagrams illustrating lubrication points
- 1.04 - C.5 ____ Troubleshooting Guide
- 1.04 - C.6 ____ Detailed parts list, manufacturer's part number and exploded view
- 1.04 - C.6 ____ List of recommended spare parts and predicted life of parts subject to wear
- 1.04 - C.7 ____ Electrical and instrumentation schematics
- 1.04 - C.8 ____ Special tools list
- 1.04 - C.9 ____ Closest service centers, Contact person name and addresses
- 1.04 - C.10 ____ Procedure for storing, handling and disposing of any chemicals used
- 1.04 - C.11 ____ Equip & Systems provide Control & Wiring Diag., Sequence of Operations, Charts of tag numbers, location & function of each valve
- 1.04 - C.12 ____ Suppliers O&M information will address the particular equipment furnished, with specific details on operation and maintenance practices

Remarks: _____**END OF SECTION**

Part 1 General

1.1 Contractor Maintenance and Warranty

- A. The Contractor shall maintain and keep in good repair the work covered by these Drawings and Specifications until Substantial Completion.
- B. The Contractor shall warrant for a period of one year from the date of Substantial Completion, as defined in the Contract Documents, that the completed work is free from all defects due to faulty products or workmanship and the Contractor shall promptly make such corrections as may be necessary by reason of such defects.
- C. The Owner will give notice of observed defects with reasonable promptness. In the event that the Contractor should fail to make such repairs, adjustments or other work that may be made necessary by such defects, the Owner may do so and charge the Contractor the cost thereby incurred. The Performance Bond shall remain in full force and effect throughout the warranty period.
- D. The Contractor shall not be obligated to make replacements which become necessary because of ordinary wear and tear, or as a result of improper operation or maintenance, or as a result of improper work or damage by another Contractor or the Owner, or to perform any work which is normally performed by a maintenance crew during operation. Failures which are directly and clearly traceable to operator abuse, such as operations in conflict with published operating procedures or improper maintenance, such as substitution of unauthorized replacement parts, use of incorrect lubricants or chemicals, flagrant over or under lubrication and using maintenance procedures not conforming with published maintenance instructions, shall be exempted from the scope of the warranty. Equipment damage due to a defective power supply shall be exempted from the scope of this warranty.
- E. The warranty does not include the costs for standard or scheduled maintenance as required in the manufacturer's standard published maintenance instructions. The manufacturer shall not be obligated to make repairs or replacements which become necessary because of ordinary wear and tear, or as a result of improper operation or maintenance, or as a result of improper work or damage by another Contractor or the Owner, or to perform any work which is normally performed by a maintenance crew during operation
- F. In the event of multiple failures of major consequences prior to the expiration of the warranty described above, the affected unit shall be disassembled, inspected and modified or replaced as necessary to prevent further occurrences. All related components which may have been damaged or rendered non-serviceable as a consequence of the failure shall be replaced. A new 12-month warranty against defective or deficient design, workmanship, and materials shall commence on the day that the item is reassembled and placed back into operation. As used herein, multiple failure shall be interpreted to mean two or more successive failures of the same kind in the same item or failures of the same kind in two or more items. Major failures may include, but are not limited to, cracked or broken housings, piping, or vessels, excessive deflections, bent or broken shafts, broken or chipped gear teeth, premature

Warranties

bearing failure, excessive wear or excessive leakage around seals. Failures which are directly and clearly traceable to operator abuse, such as operations in conflict with published operating procedures or improper maintenance, such as substitution of unauthorized replacement parts, use of incorrect lubricants or chemicals, flagrant over- or under-lubrication and using maintenance procedures not conforming with published maintenance instructions, shall be exempted from the scope of the one-year warranty. Should multiple failures occur in a given item, all products of the same size and type shall be disassembled, inspected, modified or replaced as necessary and re-warranted for one year.

- G. The Contractor shall, at Contractor's own expense, furnish all labor, materials, tools and equipment required and shall make such repairs and removals and shall perform such work or reconstruction as may be made necessary by any structural or functional defect or failure resulting from neglect, faulty workmanship or faulty materials, in any part of the work performed by the Contractor. Such repair shall also include refilling of trenches, excavations or embankments which show settlement or erosion after backfilling or placement.
- H. The Contractor shall be responsible for all road and entrance reconstruction and repairs and maintenance of same for the duration of the Correction Period, as defined in the General Conditions. In the event the repairs and maintenance are not made immediately, and it becomes necessary for the owner of the road to make such repairs, the Contractor shall reimburse the owner of the road for the cost of such repairs.
- I. In the event the Contractor fails to proceed to remedy the defects upon notification within 15 days of the date of such notice, the Owner reserves the right to cause the required materials to be procured and the work to be done, as described in the Drawings and Specifications, and to hold the Contractor and the sureties on Contractor's bond liable for the cost and expense thereof.
- J. Notice to Contractor for repairs and reconstruction will be made in the form of a registered letter addressed to the Contractor at Contractor's home office.
- K. Neither the foregoing paragraphs nor any provision in the Contract Documents, nor any special guarantee time limit implies any limitation of the Contractor's liability within the law of the place of construction.

1.2 Extended Warranties

- A. The Contractor shall provide extended warranties from the manufacturer for select equipment or systems as identified in the individual specification sections of the Contract Documents. The extended warranty period for each item shall be for the period of time as defined in the individual specification sections and shall start one year from the date of Substantial Completion, as defined in the Contract Documents, so as to coincide with the end of the Contractor's standard project warranty as defined in this section. The warranty on all replacement products shall be equal to the balance remaining on the original product.
- B. No exclusions or limitations on the manufacturer's extended warranty shall apply except as defined in this section or in the individual equipment specification sections in

the Contract Documents. The manufacturer's warranty shall include all parts, labor, expenses, freight, and equipment required for repairing or replacing equipment that fails during the extended or special warranty period or that fails to meet the minimum performance requirements. Defects occurring within the extended warranty period shall be repaired or replaced by the manufacturer at no cost to the Owner.

- C. The Owner will give notice of observed defects with reasonable promptness. In the event that the Manufacturer should fail to make such repairs, adjustments or other work that may be made necessary by such defects, the Owner may do so and charge the Manufacturer the cost thereby incurred.
- D. The Manufacturer shall not be obligated to make replacements which become necessary because of ordinary wear and tear, or as a result of improper operation or maintenance, or as a result of improper work or damage by another entity or the Owner, or to perform any work which is normally performed by a maintenance crew during operation. Failures which are directly and clearly traceable to operator abuse, such as operations in conflict with published operating procedures or improper maintenance, such as substitution of unauthorized replacement parts, use of incorrect lubricants or chemicals, flagrant over or under lubrication and using maintenance procedures not conforming with published maintenance instructions, shall be exempted from the scope of the warranty. Equipment damage due to a defective power supply shall be exempted from the scope of this warranty.
- E. The extended warranty does not include the costs for standard or scheduled maintenance as required in the manufacturer's standard published maintenance instructions. The manufacturer shall not be obligated to make repairs or replacements which become necessary because of ordinary wear and tear, or as a result of improper operation or maintenance, or as a result of improper work or damage by another entity or the Owner, or to perform any work which is normally performed by a maintenance crew during operation.
- F. In the event of multiple failures of major consequences prior to the expiration of the warranty described above, the affected unit shall be disassembled, inspected and modified or replaced as necessary to prevent further occurrences. All related components which may have been damaged or rendered non-serviceable as a consequence of the failure shall be replaced. A new extended warranty against defective or deficient design, workmanship, and materials shall commence on the day that the item is reassembled and placed back into operation. As used herein, multiple failure shall be interpreted to mean two or more successive failures of the same kind in the same item or failures of the same kind in two or more items. Major failures may include, but are not limited to, cracked or broken housings, piping, or vessels, excessive deflections, bent or broken shafts, broken or chipped gear teeth, premature bearing failure, excessive wear or excessive leakage around seals. Failures which are directly and clearly traceable to operator abuse, such as operations in conflict with published operating procedures or improper maintenance, such as substitution of unauthorized replacement parts, use of incorrect lubricants or chemicals, flagrant over- or under-lubrication and using maintenance procedures not conforming with published maintenance instructions, shall be exempted from the scope of the one-year warranty. Should multiple failures occur in a given item, all products of the same size and type shall be disassembled, inspected, modified or replaced as necessary and re-warranted for one year.

Warranties

- G. In the event the Manufacturer fails to proceed to remedy the defects upon notification within 15 days of the date of such notice, the Owner reserves the right to cause the required materials to be procured and the work to be done, as described in the Drawings and Specifications, and to hold the Manufacturer liable for the cost and expense thereof.
- H. Notice to Manufacturer for repairs and reconstruction will be made in the form of a registered letter addressed to the Contractor at Contractor's home office.
- I. Neither the foregoing paragraphs nor any provision in the Contract Documents, nor any special guarantee time limit implies any limitation of the Manufacturer's liability within the law of the place of construction.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Scope

- A. The work under this Section includes, but is not necessarily limited to, the compiling, maintaining, recording and submitting of Project record documents as herein specified.
- B. Record documents include, but are not limited to:
 - 1. Drawings;
 - 2. Specifications;
 - 3. Change orders and other modifications to the Contract;
 - 4. Engineer field orders or written instructions, including Requests for Information (RFI) and Clarification Memorandums;
 - 5. Reviewed shop drawings, product data and samples;
 - 6. Test records.
- C. The Contractor shall maintain on the Project site throughout the Contract Time an up to date set of Record Drawings.

1.2 Maintenance of Documents and Samples

- A. Storage
 - 1. Store documents and samples in the Contractor's field office, apart from documents used for construction.
 - 2. Provide files and racks for storage of documents.
 - 3. Provide locked cabinet or secure storage space for storage of samples.
- B. File documents and samples in accordance with format of these Specifications.
- C. Maintenance
 - 1. Maintain documents in a clean, dry, legible condition and in good order.
 - 2. Do not use record documents for construction purposes.
 - 3. Maintain at the site for the Owner one copy of all record documents.
- D. Make documents and samples available at all times for inspection by Engineer.

Record Documents

- E. Failure to maintain the Record Documents in a satisfactory manner may be cause for withholding of a certificate for payment.

1.3 Quality Assurance

- A. Unless noted otherwise, Record Drawings shall provide dimensions, distances and coordinates to the nearest 0.1 foot.
- B. Unless noted otherwise, Record Drawings shall provide elevations to the nearest 0.01 foot for all pertinent items constructed by the Contractor.

1.4 Recording

- A. Label each document "Project Record" in neat, large printed letters.
- B. Recording
 - 1. Record information concurrently with construction progress.
 - 2. Do not conceal any work until required information is recorded.

1.5 Record Drawings

- A. Record Drawings shall be reproducible, shall have a title block indicating that the drawings are Record Drawings, the name of the company preparing the Record Drawings, and the date the Record Drawings were prepared.
- B. Legibly mark drawings to record actual construction, including:
 - 1. All Construction
 - a. Changes of dimension and detail.
 - b. Changes made by Requests for Information (RFI), field order, clarification memorandums or by change order.
 - c. Details not on original Drawings.
 - 2. Site Improvements, Including Underground Utilities
 - a. Horizontal and vertical locations of all exposed and underground utilities and appurtenances, both new facilities constructed and those utilities encountered, referenced to permanent surface improvements.
 - b. Location of and dimensions of roadways and parking areas, providing dimensions to back of curb when present.

- c. The locations shall be referenced to at least two easily identifiable, permanent landmarks (e.g., power poles, valve markers, etc.) or benchmarks.

3. Structures

- a. Depths of various elements of foundation in relation to finish first floor datum or top of wall.
- b. Location of internal and buried utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.

1.6 Specifications

A. Legibly mark each section to record:

- 1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
- 2. Changes made by Requests for Information (RFI), field order, clarification memorandums, or by change order.

1.7 Submittal

A. At contract closeout, deliver Record Documents to the Engineer for the Owner.

B. Accompany submittal with transmittal letter, in duplicate, containing:

- 1. Date.
- 2. Project title and number.
- 3. Contractor's name and address.
- 4. Title and number of each record document.
- 5. Signature of Contractor or Contractor's authorized representative.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Spare parts, as identified in Specification sections.
- B. No separate payment will be made for Spare Parts and the cost of such parts shall be included in the Contract Price.

1.2 Spare Parts and Maintenance Materials

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual Specification sections.
- B. All equipment, spare parts, and tools provided by Contractor, Subcontractor, or Supplier shall be properly marked to identify the associated equipment by name, P&ID tag number (if applicable) and manufacturer part number. Parts shall be packaged in a manner for protection against damage from the elements during shipping, handling, and long-term storage. All spare parts and special tools shall be packaged complete and shipped at one time in appropriately sized, hinged-covered, hard plastic or metal boxes. The boxes shall be marked to indicate all contents by name and part number.
- C. Provide list of recommended spare parts in addition to those required by the Specifications.
- D. Use the attached Spare Parts Transfer Form to document the transfer of spare parts and special tools to the Owner.

Part 2 Products

(NOT USED)

Part 3 Execution

(NOT USED)

END OF SECTION

SPARE PARTS TRANSFER FORM

DATE: _____

PROJECT: _____

SPEC SECTION: _____ TITLE: _____

VENDOR: _____

No.	Spec No.	Quantity	Part No.	Manufacturer & Item Description
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

The above-listed spare parts have been inspected and inventoried, and are hereby accepted, subject to all Contract Provisions, by the Owner.

Received by: _____ Date: _____

Owner's Representative

Part 1 General

1.1 Work Included

- A. Demolition of designated structures, foundations, below-grade structural features, mechanical equipment, electrical equipment, utilities, and other existing facilities.
- B. Unless otherwise noted, remove all demolition material from the project site and properly dispose of all demolition material at a location selected and provided by the Contractor.

1.2 Related Sections

- A. Section 01 11 00 - Summary of Work.

1.3 Demolition Plan

- A. Prepare a Demolition Plan and submit proposed demolition and removal procedures for approval before work is started. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a disconnection schedule of utility services, and a detailed description of methods and equipment to be used for each operation. Plan shall be approved by the Owner prior to work beginning.
- B. General Requirements: Do not begin demolition or deconstruction until authorization is received from the Owner. Remove rubbish and debris from the project site; do not allow accumulations. Store materials that cannot be removed daily in areas agreed upon by the contractor and the Owner.

1.4 Items to Remain in Place

- A. Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Owner. Repair or replace damaged items as approved by the Engineer. Coordinate the work of this section with all other work indicated.
- B. Do not overload pavements to remain.
- C. Existing Construction Limits and Protection: Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove dust, dirt, and debris from work areas daily.
 - 1. Utility Service: Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations. Prior to start of work, utilities serving each area of alteration or removal will be shut off by the Owner and disconnected and sealed by the Contractor.

D. 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 components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Engineer. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.5 Burning

- A. The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.6 Submittals

- A. Submit the following in accordance with Section 01 33 00 - Submittal Procedures.
- B. Existing Conditions Survey.
- C. Demolition Plan.

1.7 Quality Assurance

- A. Comply with federal, state, and local hauling and disposal regulations.
- B. Use of explosives will not be permitted.
- C. Dust Control: 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.

1.8 Existing Conditions

- A. Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Engineer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs sized 4 inch by 6 inch or electronic photographs of equivalent resolution will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and

extent of existing cracks and other damage and description of surface conditions that exist before starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work and to note these outages on the record document.

Part 2 Products

(NOT USED)

Part 3 Execution

3.1 Existing Facilities to be Removed

- A. Remove existing structures indicated to be removed to grade. Interior walls, other than retaining walls and partitions, shall be removed to three feet below grade (unless noted otherwise) or to top of concrete slab on ground.
- B. Demolish structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods.
- C. Locate demolition and deconstruction equipment throughout the structure and remove materials, so as to not impose excessive loads to supporting walls, floors, or framing.
- D. Remove sidewalks, curbs, and gutters as indicated.
- E. Utilities and Related Equipment
 - 1. General Requirements: Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Engineer. Do not begin demolition work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.
 - 2. Disconnecting Existing Utilities: Remove existing utilities, uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Engineer. When utility lines are encountered but are not indicated on the drawings, notify the Engineer prior to further work in that area. Remove meters and related equipment and deliver to Owner in accordance with instructions of the Engineer.
- F. Paving and Slabs
 - 1. Remove sawcut concrete and asphaltic concrete paving and slabs as indicated. Provide neat sawcuts at limits of pavement removal.

G. Concrete

1. Saw concrete along straight lines to a depth of a minimum **2 inch**. 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.

H. Patching

1. Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces, using on-site materials when available. 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. Finished surfaces of patched area shall be flush with the adjacent existing surface and shall match the existing adjacent surface as closely as possible as to texture and finish. For concrete and masonry, completely fill holes and depressions, left as a result of removals in existing masonry walls to remain, with an approved masonry patching material, applied in accordance with the manufacturer's printed instructions.

I. Mechanical Equipment and Fixtures

1. Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Disconnect mechanical equipment and fixtures at fittings. Remove service valves attached to the unit.
2. Do not remove equipment until approved.
3. Tanks, piping and fixtures shall be drained; interiors, if previously used to store flammable, explosive, or other dangerous liquids, shall be purged and hazardous material shall be disposed of per applicable law. Seal openings with caps, plates, or plugs.

J. Piping: Disconnect piping at unions, flanges and valves, and fittings. Carefully dismantle piping that previously contained gas, gasoline, oil, or chlorine gas or solution, with precautions taken to prevent injury to persons and property.

K. Electrical Equipment and Fixtures

1. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.
2. Electrical Devices: Remove switches, switchgear, transformers, conductors including wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items.
3. Wiring Ducts or Troughs: Remove wiring ducts or troughs.

4. Conduit and Miscellaneous Items: Remove conduit except where embedded in concrete or masonry.

3.2 Disposition of Material

- A. Title to Materials: All non-salvageable materials and equipment shall become the property of the Contractor and shall be removed from Owner's property. Title to non-salvageable materials resulting from demolition, and non-salvageable materials and equipment to be removed, is vested in the Contractor, unless otherwise indicated by the Owner.

3.3 Cleanup

- A. Remove debris and rubbish. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.4 Disposal of Removed Materials

- A. Regulation of Removed Materials: Dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from removal operations in accordance with all applicable federal, state and local regulations.

END OF SECTION

Part 1 General

1.1 Scope

- A. The electrical demolition work commences with the point where indicated on the Drawings and includes furnishing all equipment, materials and labor to accommodate new work.
- B. Scheduling: Coordinate all demolition and modification work with the requirements of Division 01 of these Specifications.
- C. Methods of demolition work shall provide for a safe conduct of work, and protection of property which is to remain in service and undisturbed.

1.2 Submittals

- A. Submit to the Owner for review, a written detailed procedure and method for each structure to be demolished or modified. The submittal shall include approximate dates and times of de-energization of services.

Part 2 Products

(Not Used)

Part 3 Execution

3.1 Demolition

- A. Coordinate and schedule all demolition work and outages of existing services prior to starting work.
- B. Existing services and facilities damaged or otherwise interrupted by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored by the Contractor without additional cost to the Owner.
- C. Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at pre-arranged times approved by the Owner. Interruptions shall only occur after the provision of all necessary temporary work and the availability of adequate labor and materials has been assured that the duration of the interruption will not exceed the time agreed upon.
- D. Existing materials shall remain the property of the Owner and shall be stored at a location and in a manner as directed, or if classified by the Owner as unsuitable for

further use, shall become the property of the Contractor and shall be removed from the site.

- E. All underground ductbanks and conduits which are not being reused and are not in conflict with the new work shall be abandoned, capped and tagged.
- F. All exposed conduits to be removed in structures or buildings shall be cut and plugged flush with structure or floor.
- G. All wiring to be removed shall be disconnected at distribution panels or MCCs. All wiring which serves equipment to be removed shall be removed.
- H. Schedule: Demolish electrical equipment from structures as indicated or as required to facilitate the installation of new equipment and work. See One-Line Diagram on the Drawings and description below.
 - 1. Electrical Equipment. Remove electrical distribution and control equipment as indicated on the One-Line Diagram. Remove all existing individual motor starters, safety disconnect switches and control panels associated with process and HVAC equipment to be demolished in the Centrifuge Area, Electrical Room, Control Room, and outdoors.
 - 2. Wiring. Remove conductors and conduit to the extent possible as indicated on the One-Line Diagram. Remove all existing wiring to and from individual motor starters, safety disconnect switches and control panels associated with process and HVAC equipment to be demolished in the Centrifuge Area, Electrical Room, Control Room, and outdoors.
 - 3. Wiring Devices. Remove all light switches, receptacles and associated conductors and conduit to the extent possible in the Polymer Tank Room, Centrifuge Area, and Electrical Room.
 - 4. Lighting. Remove all lighting fixtures and associated conductors and conduit to the extent possible in the East Loading Bay, Polymer Tank Room, Centrifuge Area, and Electrical Room.
- I. All wiring, conduit or equipment shall be disposed of in a safe manner in accordance with all applicable local, state and federal environmental agencies. Existing wire shall become property of the Contractor and shall be removed from the project site.

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Resurfacing of concrete surfaces in preparation for finish materials.
2. Non-structural crack repair of small cracks.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

1.2 Definitions

- A. Surface Repair Areas: Areas that are deemed to be defective excluding large cracks.
- B. Defective Areas: Surface defects that include honeycomb, rock pockets, and indentations greater than 3/16"; cracks 0.010" wide and larger, as well as any crack that leaks, for hydraulic structures and below grade habitable spaces; cracks 0.015" wide and larger in non-hydraulic structures; spalls; chips; air bubbles greater than 3/4" in diameter; pinholes; bug holes; embedded debris; fins and other projections; form pop-outs; texture irregularities; and stains that cannot be removed by cleaning.
- C. Large Cracks: Wider than 0.015".
- D. Small Cracks: Width greater than or equal to 0.010" and less than or equal to 0.015", as well as any smaller cracks that leak.

1.3 Submittal

A. Information Submittals:

1. Manufacturer's product data and installation bulletin.
2. Written description of equipment proposed for surface preparation.

3. Certificates:
 - a. Certificate of Compliance that proposed product systems meet or exceed specified performance criteria when tested in accordance with Article FIELD QUALITY CONTROL.
 - b. Mortar system Manufacturer's Certificate of Proper Installation.
4. Statements of Qualification:
 - a. Independent testing laboratory.
 - b. Mortar system Manufacturer's Representative.
5. Mortar system Manufacturer's proposed modified test procedures for ASTM C 109 and ASTM C 882 test methods.
6. Independent testing laboratory test report.

1.4 Quality Assurance

- A. Qualifications:
 1. Independent Testing Laboratory: Based on evaluation of laboratory submitted criteria in accordance with ASTM E 699.
 2. Mortar System Applicator: For low pressure spray mortar system in lieu of endorsement, complete mortar system manufacturer's demonstration in accordance with Article MANUFACTURER'S SERVICES.

Part 2 Products

2.1 Low Pressure Spray Mortar System (for Vertical and Overhead)

- A. Mortar: One component, rheoplastic, cement-based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.
 1. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.
 2. Free of chlorides and other chemicals causing corrosion.
- B. Manufacturer and Product equal to:
 1. Master Builders Technologies Co., MasterEmaco S 488CI with Concrecive liquid (LPL) bonding agent for hand applied areas.
 2. Sika Corp., SikaRepair 224.

2.2 Polymer-Modified Repair Mortar (Horizontal Surface Repair)

- A. Mortar: One component, polymer-modified, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar.
 - 1. Hand applied, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.
 - 2. Free of chlorides and other chemicals causing corrosion.
- B. Manufacturers and Products equal to:
 - 1. Master Builders Technologies Co., MasterEmaco T 310Cl.
 - 2. Sika Corp., SikaRepair 222.

2.3 Water

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.4 Accessories

- A. Finishing Aid Manufacturer and Product equal to: Master Builders Inc., Cleveland, OH; CONFILM.
- B. Flexible Cementitious Rebar Coating Manufacturer and Product equal to: Master Builders Inc., Cleveland, OH; EMACO P22.

Part 3 Execution

3.1 General

- A. Repair small cracks and surface defects as outlined by this specification.

3.2 Preparation

- A. Remove unsound and deteriorated concrete from Work by high pressure water blasting.
- B. Collect and dispose of water from removal operations in manner and location acceptable to Owner.
- C. Do not use power-driven jackhammers and chipping hammers, unless water blasting is prohibited due to potential damage to installed equipment.

- D. Remove concrete minimum of 1" clearance around rebar for application and bonding of new mortar to entire periphery of exposed rebar if the following surface conditions exist:
 - 1. 50% or more of periphery around rebar is exposed during removal of concrete.
 - 2. 25% or more of periphery around rebar is exposed during removal of concrete and corrosion has eventuated to the extent that loss of section has occurred.
 - 3. Bond between existing concrete and reinforcement has deteriorated.
- E. Clean exposed reinforcing bars of rust and concrete, and coat with flexible cementitious rebar coating.
- F. Maintain surface areas free of slurry where concrete has been removed. Remove slurry from prepared areas before new mortar is applied.
- G. Clean surface areas to be filled with new mortar of laitance and contamination by high pressure water blasting not more than 24 hours before applying bonding agent, Saturated Surface Dry (SSD) existing concrete at time of application of mortar.

3.3 Low Pressure Spray Mortar Application

- A. Apply mortar according to manufacturer's written instructions.
- B. Finish mortar with a hand float application to smooth even surface matching adjacent concrete. Provide finishing aid at full strength.
- C. Bonding Agent:
 - 1. Hand apply bonding agent within 20 minutes of troweling on mortar. Prevent bonding agent from drying by reapplying bonding agent to maintain surface tackiness of coat.
 - 2. Work mortar firmly and quickly into area and compact with firm trowel stroke. Finish smooth with finishing aid at full strength.

3.4 Polymer-Modified Repair Mortar Application for Repair of Horizontal Surfaces

- A. Hand Troweling: Apply according to manufacturer's written instructions.
- B. Work material firmly into the side and bottom of patch to assure a good bond. Level repair mortar and screed to elevation of existing concrete.
- C. Finish to same texture as existing concrete around patch.
- D. Use self-leveling mixture where appropriate to obtain uniform or plane surface.

- E. Use Manufacturer's standard bonding agent for applications of old to new concrete and as otherwise recommended by manufacturer.

3.5 Curing

- A. Water fog nozzle all of the mortar systems prior to curing in accordance with mortar system Manufacturer's instructions.
- B. Commence water curing after mortar system application and when curing will not cause erosion of mortar.
- C. Continuously cure mortar system for a period of 7 days.
- D. Do not cure membrane, unless method is part of mortar system Manufacturer's instructions and approval has been obtained.

3.6 Field Quality Control

- A. Independent testing laboratory shall perform the following:
 - 1. Obtain actual core samples from the completed repair Work and test, if periodic testing is required by the Owner or as required by Engineer.
 - 2. Perform "modified" ASTM C 109 and ASTM C 882 test methods in accordance with manufacturer's approved modifications of testing procedures.
- B. Construction Testing:
 - 1. Production Samples:
 - a. Obtain mixed mortar material from shotcrete or spray equipment and produce samples, and cure samples prior to testing.
 - b. Provide minimum of three samples each test for each 1,000 square feet or portion thereof of mortar repair to be installed.
 - 2. Core Samples of In-Place Repair:
 - a. Obtain two core samples and test samples for each 2,000 square feet or portion thereof for actual repair Work:
 - b. Cores shall be either 2-1/2" or 3" in diameter and shall be cored through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness.
 - c. Sawcut the cores after removal to trim base concrete thickness to same thickness as mortar so that bond line is at center of repaired sample.
 - d. Samples shall be epoxy bonded to steel plates at each end using a bonding agent to prevent failure in bond to steel plates.

- e. Sustain bond line without failure or movement with a minimum of 300 psi in direct tension. The tension test shall use eyebolts or threaded connectors tapped and threaded into base plate so that tension load is concentric with center of core sample.
- C. Repair and fill holes where core samples have been removed using same mortar used in repair.

3.7 Manufacturer's Services

- A. Provide mortar system manufacturer's representative at site for installation assistance, inspection and certification of proper installation, and training of mortar system applicators.

3.8 Protection

- A. Protect adjacent surfaces, and equipment, from being damaged by overshooting of low pressure spray mortar.

3.9 Cleaning

- A. Remove overshot mortar and deposited rebound materials as Work proceeds. Remove from Work, waste materials, unsound material from concrete surfaces, material chipped from walls, water used in preparation of application and finishing.

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Concrete formwork.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

1.2 References

A. Comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

B. American Concrete Institute (ACI):

1. 117, Standard Specifications for Tolerances for Concrete Construction and Materials.
2. 318/318R, Building Code Requirements for Reinforced Concrete.
3. 347, Formwork for Concrete.

1.3 Design Requirements

A. Design, erect, shore, brace, and maintain formwork in accordance with ACI 301, ACI 347, and ACI 318 to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads. Provide concrete finishes specified in Section 03 30 00 - Cast-in-Place Concrete.

1. Formwork shop drawings shall be prepared by or under the supervision of a qualified professional engineer licensed in the state of the work.

B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure per ACI 347.

C. Make joints in forms tight enough to prevent loss of concrete mortar.

D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.

1.4 Submittals

A. Shop Drawings:

1. Form Ties-Tapered Through-Bolts: Proposed method of sealing form tie hole; coordinate with details shown.
2. All formwork erection, shoring and removal are the responsibility of the Contractor and/or the qualified professional engineer the contractor used for the formwork drawings.
3. Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing re-shoring.
4. Manufacturer's Data for the Following Product: Form release agent.
5. Formwork drawings shall be signed and sealed by the professional engineer licensed in the state of the work and responsible for their preparation.

B. Samples: One each as follows:

1. Form ties.

1.5 Qualifications

- ### A. Formwork Designer: Formwork, falsework, and shoring design shall be by a Qualified Professional Engineer licensed in the state of the work.

Part 2 Products

2.1 Form Materials

A. Wall Forms and Underside of Slabs:

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. Circular Structures:
 - a. Conform forms to circular shape of structure.
 - b. Straight panels may be substituted for circular forms provided panels do not exceed 2' in horizontal width and angular deflection is no greater than 3-1/2° per joint.

- #### B. Painted Surface Forms: High density overlay plywood for flat concrete surfaces to be painted.

- C. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints. Furnish on exposed surfaces and interior surfaces.
- D. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit. Permitted to furnish on below grade exterior surfaces
- E. Forms for Cylindrical Columns, Pedestals, and Supports: Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- F. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- G. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- H. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- I. Form Release Agent:
 - 1. Material: Release agent shall not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatments of concrete surfaces when applied to forms. A "ready-to-use" water-based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations and can be used in potable water facilities.
 - 2. Manufacturers and Products:
 - a. Master Builders, Inc.; Rheofinish 211.
 - b. Cresset Chemical Company; Crete-Lease 20-VOC.
 - c. US Mix Products Company; US SPEC Slickote.
 - d. Or approved equal.
- J. 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.
- K. Form Ties:
 - 1. Material: Steel.
 - 2. Spreader Inserts:
 - a. Conical or spherical type.

- b. Design to maintain positive contact with forming material.
 - c. Furnish units that will leave no metal closer than 1" to concrete surface when forms, inserts, and tie ends are removed.
- 3. Wire ties not permitted.
- 4. Flat bar ties for panel forms furnish plastic or rubber inserts with minimum 1" depth and sufficient dimensions to permit patching of tie hole.
- 5. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
 - a. Integral steel water stop 0.103" thick and 0.625" in diameter tightly and continuously welded to tie.
 - b. Neoprene water stop 3/16" thick and 15/16" diameter whose center hole is 1/2-diameter of tie, or molded plastic water stop of comparable size.
 - c. Orient water stop perpendicular to tie and symmetrical about center of tie.
 - d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
- 6. Through-Bolts: Tapered minimum 1" diameter at smallest end.
- 7. Elastic Vinyl Plug:
 - a. Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length and diameter upon removal forming watertight seal.
 - b. Manufacturer and Product: Dayton/Richmond Co., Miamisburg, OH; A58 Sure Plug, or approved equal.
 - c. Recess plug 1" minimum and grout over hole. See Section 03 60 00 - Grout.

Part 3 Execution

3.1 Form Surface Preparation

- A. 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 prior to coating surface.
- B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by the manufacturer.

- C. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

3.2 Erection

- A. General: Unless specified otherwise, follow applicable recommendations of ACI 347.
- B. Beveled Edges (Chamfer):
 - 1. Form 3/4" bevels (chamfers) at all exposed concrete edges, unless otherwise shown.
- C. Wall Forms
 - 1. Do not reuse forms with damaged surfaces.
 - 2. Locate form ties and joints in an uninterrupted uniform pattern.
 - 3. Inspect form surfaces prior to installation to assure conformance with specified tolerances.
- D. Forms for Curbs and Sidewalks
 - 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, 347 and 318 and the following tolerances for finishes specified:
 - 1. Wall Tolerances:
 - a. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
 - b. Wall Type W-A:
 - 1) Plumb within 1/4" in 10' or within 1" from top to bottom for walls over 40 feet high.
 - 2) Depressions in Wall Surface: Maximum 5/16" when 10' straightedge is placed on high points in all directions.
 - c. Wall Type W-B:
 - 1) Plumb within 1/8" in 10' or within 1/2" from top to bottom for walls over 40' high.
 - 2) Depressions in Wall Surface: Maximum 1/8" when 10' straightedge is placed on high points in all directions.

2. Thickness: Maximum $-1/4"$ or $+1/2"$ from dimension shown.
3. Form Offset: Between adjacent pieces of form work, facing material shall not exceed $1/8"$ where exposed to public view and $1/4"$ maximum for all other conditions.

3.3 Additional Requirements

- A. Construct forms tight enough to prevent loss of concrete mortar.
- B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 1. Install keyways, reglets, recesses and the like for easy removal.
 2. Do not use rust-stained steel form-facing material.
 3. Use only form or form-tying methods which do not cause spalling of the concrete upon form stripping or tie removal.
- C. Set edge forms, bulkheads and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- D. Provide temporary 12 inch wide x 18 inch high openings for cleanouts and inspection ports every 7 feet at the bottom of each lift form and where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations, where possible.
- E. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds and bulkheads required in the Work.
 1. Determine sizes and locations from trades providing such items.
 2. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and waterstops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2 inches clear from the opening surfaces and encased items.
- F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris just before placing concrete.
- G. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

- H. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions before placing reinforcement.
- I. Embedded Items.
 - 1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.
 - a. Install anchor bolts/rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - b. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles and other conditions.
 - c. Check special castings, channels or other metal parts that are to be embedded in the concrete prior to and again after placing the concrete.
 - d. Check nailing blocks, plugs and strips necessary for the attachment of trim, finish and similar work prior to placing the concrete.
- J. Pipes and wall spools cast in concrete.
 - 1. Install wall spools, wall flanges, and wall anchors before placing concrete. Do not weld, tie or otherwise connect the wall spools or anchors to the reinforcing steel.
 - 2. Support pipe and fabricated fittings to be encased in concrete on concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement will occur during construction.
 - 3. Pipes or spools located below operating water level shall have waterstop ring collars and shall be cast in place. Do not block out such piping and grout after the concrete section is cast. Pipes fitted with thrust rings shall be cast in place.
- K. Removing and reusing forms.
 - 1. General: Do not remove forms from concrete which has been placed with outside temperature below 50°F without first determining and verifying with Engineer if the concrete has properly set without regard for time. Do not apply loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.
 - a. Leave formwork for structural slabs, beams and other structural elements that support weight of concrete in place until concrete has achieved 100% of its design compressive strength and a minimum of 14 days.

- b. Formwork for sides of beams, walls, columns and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50°F for 48 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - c. For structures with a structural roof slab, leave bracing for walls until the roof slab concrete reaches 100% of its design compressive strength and a minimum of 14 days.
 - d. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
 - 2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
 - 3. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved in writing by the Engineer.
- L. Aluminum surfaces in contact with concrete.
- 1. Aluminum surfaces in contact with concrete or grout or dissimilar metals shall be protected with a Mylar isolator, bituminous paint or other material approved by Engineer.
- M. Shores and reshores.
- 1. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation and removal of shoring and reshoring.
 - a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
 - 2. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
 - 3. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section includes:
 - 1. Waterstops.
 - 2. Joint Fillers.
 - 3. Vapor Barriers.
 - 4. Floor Slab Treatments.

1.2 References

- A. ASTM International (ASTM):
 - 1. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
 - 2. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 - 3. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
 - 4. ASTM D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
 - 5. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - 6. ASTM D2240 - Standard Test Method for Rubber Property - Durometer Hardness.
- B. U. S. Army Corps of Engineers (USACE):
 - 1. CRD-C-572, Specification for Polyvinyl Chloride (PVC) Waterstop.

1.3 Submittals

- A. Product Data: Provide sufficient information on each type of material for review to determine conformance of material to requirements specified.
 - 1. Waterstops: Complete physical characteristics.
 - 2. Preformed expansion joint material.

- B. Laboratory test reports: Indicating that average properties of waterstop materials and finish conform to requirements specified in this Section.
- C. Certificates of Compliance:
 - 1. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
- D. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.4 Quality Assurance

- A. Materials:
 - 1. PVC waterstops: Shall be free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. Replace faulty material.
- B. Inspections:
 - 1. Waterstop: For installation according to manufacturer's recommendations.
 - 2. Vapor Barriers: For installation according to the drawings and free from tears.
 - 3. Joint Filler: Joints shall be free of debris prior to placing joint filler.
 - 4. Floor Slab Treatment: For installation according to manufacturer's recommendations.

Part 2 Products

2.1 Waterstops

- A. Polyvinyl Chloride (PVC) Waterstops:
 - 1. General: Manufactured from polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of this Section. No scrap or reclaimed material shall be used.
 - 2. Manufacturers: One of the following or approved equal:
 - a. Greenstreak Plastic Products Company, Inc.
 - b. Vinylex Corporation.

3. Type: Ribbed with Center bulb (non-tapered):
 - a. Construction and Expansion joints: 6-inch long.
 - 1) Greenstreak Style 732.
 - 2) Vinylex RB638H.
 - b. Construction joints: 4-inch long (where indicated).
 - 1) Greenstreak Style 702.
 - c. Expansion joints: 9-inch long.
 - 1) Greenstreak Style 735.
 - 2) Vinylex RB938H.
 4. Dumbbell type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
- B. Strip-Type Waterstops:
1. General: Unless noted otherwise, strip-type waterstops shall be:
 - a. Expansive type only when waterstop is placed between two layers of reinforcing.
 - b. Non-Expansive type for all other conditions.
 2. Expansive Strip-type Waterstops Profile: 1" x $\frac{3}{4}$ "
 - a. General: Manufactured from expansive butyl rubber compound. No scrap or reclaimed material shall be used.
 - b. Install only at locations as shown on the drawings or as directed by the Engineer.
 - c. Expansive strip-type waterstops shall be installed inside of, or between, reinforcing bars, where applicable. Maintain manufacturer's minimum cover requirements at all times.
 - d. Greenstreak Swellstop.
 - e. Vinylex BlueStop.
 3. Non-expansive Strip-type Waterstops Profile: 1" x $\frac{3}{4}$ "
 - a. General: Self-sealing mastic waterstop. No scrap or reclaimed material shall be used.

- b. Install only at locations as shown on the drawings or as directed by the Engineer.
- c. Maintain manufacturer's minimum cover requirements at all times.
- d. Greenstreak Lockstop.
- e. Vinylex UltraStop.

2.2 Joint Fillers

- A. Expansion and Isolation Joint Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- B. Semi-rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D2240.
- C. Preformed expansion joint materials: No scrap or recycled material shall be used.
 - 1. Bituminous fiber expansion joint material equal to:
 - a. Tamms Industries: Hornboard/fiber.
 - 2. Synthetic sponge rubber expansion joint material equal to:
 - a. Tamms Industries: Cementone.

2.3 Vapor Barriers

- A. Plastic Vapor Barrier: ASTM E1745, Class B. Include manufacturers' recommended adhesive or pressure-sensitive tape. Minimum thickness: 15 mils.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.4 Floor and Slab Treatments

- A. General: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.5 Bonding Agents

- A. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing for bonding hardened or freshly mixed concrete to hardened concrete.

Part 3 Execution

3.1 Waterstops - Installation

- A. Waterstops shall be stored so as to permit free circulation of air around the waterstop material and to prevent direct exposure to sunlight.
- B. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
- C. In water-bearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
- D. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
- E. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
- F. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise shown on the Drawings.
- G. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
 1. The material shall not be damaged by heat sealing.
 2. Make joints by overlapping, cut the ends of the sections to be spliced so they will form a smooth even joint. Heat the cut ends with the splicing tool until the plastic melts. Press the two ends together until the plastic cools.
 3. The continuity of the waterstop ribs and tubular center axis shall be maintained.
 4. The splices shall have a tensile strength of not less than 60 percent of the unspliced materials tensile strength.
- H. Butt joints of the ends of two identical waterstop sections may be made while the material is in the forms.
- I. Joints for crosses and tees shall be factory prefabricated by the manufacturer.

3.2 Vapor Retarders

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E1643 and manufacturer's written instructions.

- B. Lap joints 6 inches or as required by the manufacturer and seal with manufacturers' recommended tape.

3.3 Joints

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.
- C. Construction Joints:
 - 1. Install so strength and appearance of concrete are not impaired.
 - 2. Provide joints only as indicated on the drawings or as approved by the Engineer.
 - 3. All joints in hydraulic structures to have waterstops.
 - 4. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- D. Contraction Joints in Slabs-on-Grade:
 - 1. Form weakened-plane contraction joints, in slabs-on-grade only as indicated on the drawings.
 - 2. No slabs for hydraulic structures shall have contraction joints, unless indicated otherwise on the drawings.
 - 3. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 4. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/4-inch wide joints maximum into concrete, when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- E. Isolation Joints in Slabs-on-Grade:
 - 1. Extend joint filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 - 2. Terminate full-width joint filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants are indicated.

3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

F. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated. Lubricate or epoxy-coat one-half of dowel length to prevent concrete bonding to one side of joint.

G. Joint Filling

1. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - a. Defer joint filling until concrete has aged at least 90 days. Do not fill joints until construction traffic has permanently ceased.
2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.4 Liquid Floor Treatments

A. Penetrating Liquid Floor Treatment:

1. Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
2. Do not apply to concrete that is less than 28 days old.
3. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
4. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. Reinforcing steel and related items required for cast-in-place concrete.
- B. Related Sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

1.2 References

- A. American Concrete Institute (ACI):
 - 1. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
 - 3. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- B. Concrete Reinforcing Steel Institute (CRSI) - Manual of Concrete Practice.

1.3 Supervision

- A. Workmanship: Provide qualified supervision at all times reinforcing work is in progress. Workmen shall be experienced iron workers.
- B. Codes: Reinforcement placement and detailing shall comply with practice specified in the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" publication ACI 315- latest edition of the American Concrete Institute or its latest revision, unless otherwise specified herein.

1.4 Submittals

- A. Shop drawings: Shop drawings shall be prepared for all reinforcement required by the project. Shop drawings shall be logically and legibly prepared to permit

reasonable ease of sorting, selecting, placing reinforcement as well as checking drawings. Preparer and fabricator shall be identified on the drawings.

1. Reinforcement shall not be fabricated until the shop drawings have been processed, approved and returned.
2. Check all shop drawings to verify reinforcement dimensions required by drawings are satisfied.
3. Provide bar sizes, bar lengths, bar material, bar grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and lap lengths, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

B. Reinforcement shop drawings:

1. Review of reinforcement shop drawings by the Engineer will be limited to general compliance with the Contract Documents.
2. Submit reinforcement shop drawings in a complete package for each specific structure. Partial submittals will be rejected.

C. Changes to reinforcing steel contract drawing requirements:

1. Indicate in separate letter submitted with shop drawings any changes of requirements indicated on the Drawings for reinforcing steel.

D. Such changes will not be acceptable unless the Engineer has accepted such changes in writing.

1.5 Product Handling

A. Protection:

1. Use all means necessary to protect reinforcement from dirt and other foreign substances before and after placing.
2. Store in a neat manner in logical order, bundled, tagged, off the ground, and in an area adequately isolated.
3. Re-bundle to maintain identification when placing is interrupted.

B. Replacement: All damaged or improperly fabricated bars shall be replaced at the Contractor's expense.

Part 2 Products

2.1 Concrete Reinforcement

A. General:

1. All reinforcement bars shall be deformed, carbon steel bars in accordance with ASTM A615 Grade 60.
2. All reinforcement shall be free from rust, loose mill scale, and other contaminants.

B. Wire bar supports located between reinforcing bars and face of concrete:

1. Stainless steel. Type 304 stainless steel bar supports.
2. Support reinforcing for concrete placed on ground using bar support chairs with Type 304 stainless steel plates for resting on ground welded to the chairs.

C. Concrete bar supports located between reinforcing bars and face of concrete:

1. Manufactured expressly for supporting reinforcing bars.
2. Manufactured with two annealed steel wires to securely tie concrete bar support to reinforcing steel.
3. Manufactured with f'_c at least 1,000 psi greater than concrete compressive strength.

2.2 Welded Wire Reinforcement (WWR)

A. General:

1. All WWR shall be carbon steel, welded wire in accordance with ASTM A1064.
2. WWR may not be used in place of reinforcing bars unless accepted in writing by the Engineer.
3. Provide WWR in flat sheet form.

2.3 Accessories

A. General: Accessories shall be subject to Engineer's approval.

B. Tie wire - 18 gauge annealed steel wire.

C. Number of chairs shall be adequate to prevent sag during steel and concrete placement.

D. Wall layer spacers shall be 1/4 inch round "Z" bar.

- E. Horizontal layer spacers shall be wire bar supports or reinforcing bars bent to support top layer.
- F. Dowel bar splicer shall be Richmond or approved equal, manufactured from standard specified rebar material, with NC threads and shop fabricated to specified dowel configurations.
- G. Expansion Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
 - 1. All dowels shall be placed and securely anchored before placing concrete. All dowels shall be parallel with each other and perpendicular to the joint.
- H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. Secure all reinforcement in place using steel chairs, supports, "A" bars and any other ACI approved product. Supports shall be spaced adequately to support the steel firmly in place.
 - 3. Chairs will not be accepted to hold reinforcing clearance on walls.

Part 3 Execution

3.1 General

- A. Coordinate all work of other trades to avoid conflict with reinforcement.
- B. Contractor is responsible for checking shop drawings to verify compliance with the drawings. Prior to submitting shop drawings to the Engineer, the contractor shall confirm all bar materials, quantities, sizes, and spacings, as well as all bent bar and lap splice lengths.

3.2 Fabricating

- A. General: Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice." Reinforcement shall be shop fabricated except where straight bars No. 5 or smaller are required.
- B. Bending: All bending shall be by using bending jigs and mandrels. All bars shall be bent cold.

- C. Cutting: Bars shall be cut by cold shearing. Torch cutting in the field may be permitted in special situations.

3.3 Preparation

A. Surface Preparation:

1. Reinforcing bars: Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean any bars having rust scale, loose mill scale, or thick rust coat.
2. Cleaning of reinforcement materials: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placement.

3.4 Placing

A. General:

1. Accurately place all bars to meet tolerances as outlined in ACI 318 and tie in place before placing concrete, include dowels. Tie with 18 gauge steel wire.
2. Corner bars required for horizontal reinforcing.
3. No field bending of bars will be allowed.

B. Clearance:

1. Preserve clearance between bars of 1 inch minimum, not less than one bar diameter or 1-1/3 times large aggregate, whichever is larger.
2. Clear cover shall be as shown in the drawings.
3. Lap all reinforcing bars with a Class B Tension lap or as required by ACI 318.
4. Stagger splices except where otherwise shown.
5. Lap welded wire reinforcement a minimum of two spaces.

C. Supports:

1. Provide a sufficient number to prevent sagging, to prevent shifting, and to support loads during construction; but in no case less than quantities and at locations as indicated in ACI 315.
2. Do not use brick, broken concrete masonry units, spalls, rocks, wood or similar materials for supporting reinforcing steel.

3. Do not use reinforcing bars that have less cover than required by the Contract Documents. Do not adjust location of reinforcement required by the Contract Documents to provide cover to these bars.
4. Wire chairs will not be accepted to hold reinforcing clearance on walls.

D. Tying of bar reinforcement:

1. Fasten bars securely in place with wire ties.
2. Tie bars sufficiently to prevent shifting during construction or concrete placement.
3. Tie slab bars at every intersection around periphery of slab.
4. Tie wall bars at not greater than following maximum spacings:

Bar Size	Slab Bar Spacing Inches	Wall Bar Spacing Inches
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

5. After tying wire ties, bend ends of wire ties in towards the center of the concrete section.
 - a. The cover for wire ties shall be the same as the cover requirements for reinforcing bars.

E. Openings and obstructions:

1. Place additional reinforcing around openings as shown on the drawings and standard details.
2. Consult Engineer on special situations.

F. Welded Wire Reinforcement:

1. Install necessary supports to keep WWR in place while concrete is being placed.
2. Straighten fabric to make flat sheet before placing.
3. Splice fabric in accordance with ACI 318.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section includes cast-in-place concrete, including concrete materials, concrete mixture designs, placement procedures, and finishes.
- B. Related Sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - a. See Section 03 01 00 - Concrete Surface Repair Systems for concrete patching and surface repairs.
 - b. See Section 03 11 00 - Concrete Formwork for additional requirements.
 - c. See Section 03 15 00 - Concrete Accessories for related materials.
 - d. See Section 03 20 00 - Concrete Reinforcement for additional requirements.

1.2 References

- A. Comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
- B. American Concrete Institute (ACI):
 - 1. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - 3. ACI 301 - Specifications for Structural Concrete.
 - 4. ACI 302.1R - Guide for Concrete Floor and Slab Construction.
 - 5. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
 - 6. ACI 305 - Hot Weather Concreting Standard.
 - 7. ACI 306 - Cold Weather Concreting Standard.

8. ACI 308.1 - Standard Specification for Curing Concrete.
9. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
10. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.

C. ASTM International (ASTM):

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33 - Standard Specification for Concrete Aggregates.
3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
6. ASTM C150 - Standard Specification for Portland Cement.
7. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
8. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
9. ASTM C192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
10. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
11. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
12. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
13. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
14. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
15. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete.

1.3 Definitions

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
- B. Exposed Concrete: Concrete surface that can be seen inside or outside of structures regardless whether concrete is above water, dry at all times, or can be seen when structure is drained.
- C. Hydraulic Structures: Liquid containing basins including, but not limited to: clarifiers, aerations basins, digesters, wet wells, hydraulic channels, pipe trenches, sumps.

1.4 Submittals

- A. Product Data: For each type of product indicated.
- B. Concrete Mixture Designs: For each concrete mixture.
 - 1. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 2. Indicate amounts of mixing water to be withheld for later addition at Project site.
 - 3. Concrete Mixture Compressive Strength.
 - a. Testing shall be in accordance with ACI 350.
 - b. Testing results shall be from tests conducted within the 12-month period prior to this submittal.
 - c. Provide one copy of 30 consecutive strength test results, for each mix design used, from a record of past performance.
 - d. Or one copy of the project specific laboratory trial mix design and testing results, for each concrete mix used in this project.
- C. Welding certificates.
- D. Qualification Data: For manufacturer testing agency.
- E. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Curing compounds.
 - 4. Bonding agents.

- 5. Adhesives.
- 6. Course Aggregate Gradation.
- 7. Fine Aggregate Gradation.
- F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- G. Field quality-control test and inspection reports.
- H. Material Test Reports: for the following, from a testing agency acceptable to the Engineer and Owner, indicating compliance with requirements:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- I. Ready-Mix concrete.
 - 1. Provide delivery tickets for ready-mix concrete, or weigh-masters certificate, per ASTM C94 including weights of cement and each size aggregate and amount of water added at the plant and record of pours.
 - 2. Keep record showing time and place of each pour (placement) of concrete, together with transit-mix delivery slips certifying the contents of the pour (placement).
 - 3. Furnish records to Engineer upon request.

1.5 Quality Assurance

- A. Comply with the requirements outlined in the listed references, unless modified by the contract documents.
- B. Installer Qualifications: Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- C. Manufacturer Qualifications: A firm with a minimum of 5 years' experience in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
 - 2. The criteria hereinafter set out are solely for the purpose of establishing required mixture proportions and do not constitute a basis for confirming the adequacy of concrete strength.

- D. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests and/or laboratory tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - 2. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- G. Pre-installation Conference: Conduct conference at Project site prior to beginning the work.
 - 1. Representatives of each entity directly concerned with cast-in-place concrete are required to attend.

Part 2 Products

2.1 Manufacturers

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements products that may be incorporated into the work include but are not limited to products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 Concrete Materials

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement (Non-hydraulic Above Grade Structures): ASTM C150, Type I or II, or combination of Type I with fly ash.
 - 2. Portland Cement (Hydraulic and/or Below Grade Structures): ASTM C150 Type II with fly ash.

3. Fly Ash: ASTM C618, Class C or F fly ash.
 - a. Limit fly ash content to maximum of 20% of cementitious materials by weight.
 - b. Class C fly ash is not permitted without written approval from the Engineer.
- B. Normal-Weight Aggregates: ASTM C33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 1. Maximum Coarse-Aggregate Size: 1" nominal.
 2. Fine aggregate:
 - a. Free of materials with deleterious reactivity to alkali in cement.
 - b. Provide fine aggregate consisting of clean, natural sand or prepared from crushed stone or crushed gravel.
 - c. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with ASTM C33.
 3. Coarse aggregate:
 - a. Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
 - b. Not exceeding 15 percent by weight, of thin or elongated pieces having length greater than 5 times average thickness.
 - c. Free of deleterious substances.
 - d. Coarse aggregate shall be washed prior to combining in concrete mix.
 4. Grading:
 - a. Aggregate for building elements and hydraulic structures: In accordance with ASTM C33, #57.
- C. Water: ASTM C94 and potable (not recycled water).
 1. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement for non-hydraulic structures and 0.10 percent by weight of cement for hydraulic structures.

2.3 Admixtures

- A. Air-Entraining Admixture: In accordance with ASTM C260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 2. Retarding Admixture: ASTM C494/C494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.

2.4 Concrete Mixtures, General

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing or high-range water-reducing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.5 Concrete Mixtures

- A. Proportion normal-weight concrete mixture as follows for all structural elements:
 - 1. Minimum Compressive Strength: 4,500 psi at 28 days.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.42.
 - 3. Minimum Cementitious Materials Content: 535 lb. /cu yd.

4. Slump Limit: 8-inches max for concrete with verified slump of 2 to 4-inches before adding high range water-reducing admixture or plasticizing admixture per ACI 301.
 5. Air Content: 5% percent, plus or minus 1.5% at point of delivery.
- B. Proportion normal-weight concrete mixture as follows for all non-structural elements:
1. Minimum Compressive Strength: 3,000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 3. Slump Limit: 8 inch for concrete with verified slump of 2" to 4": before adding high-range water-reducing admixture or plasticizing admixture per ACI 301.
 4. Air content: 5 1/2%, plus or minus 1.5% at point of delivery.
- C. All slabs with a troweled finish shall have a maximum air content of 3%.

2.6 Concrete Mixing

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and ASTM C1116, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 2. For mixer capacity larger than 1 cu. yd., increase mixing times by 15 seconds for each additional 1 cu. yd.
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

2.7 Curing Materials

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

- C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A. Compatible with penetrating liquid floor treatment for surfaces specified to receive penetrating liquid floor treatment.

Part 3 Execution

3.1 Concrete Placement

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- C. Hydraulic Structures:
 - 1. Provide a minimum of 7-days between adjacent concrete pours. Additionally, concrete strength shall meet or exceed 70% of the specified design compressive strength prior to placing adjacent pours.
- D. Joints:
 - 1. Joint material and preparation shall be in accordance with 03 15 00 - Concrete Accessories.
 - 2. Joints shall be placed at locations shown or as indicated on the drawings. If additional joints are required, the contractor may submit joint placement to the Engineer for review.
- E. Walls:
 - 1. Deposit concrete continuously in one layer or in horizontal layers as shown on the drawings.
 - 2. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 3. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.

F. Floors/Slabs:

1. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
2. Maintain reinforcement in position during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

G. Cold-Weather Placement: Comply with ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete temperature within the temperature range required by ACI 301.
3. All embedded items such as wall pipes, embed frames, steel guide rails, channels, etc. (not including conduit and reinforcing) shall be considered "massive embedments" per ACI 306.1 and are required to be kept above 32 deg F during placement and for the first 48 hours after placement. Contractor shall take the necessary measures; including insulated blankets, heated blankets, and heaters; to insure items are kept above 32 deg F. All other methods shall be submitted to the Engineer for approval.
4. Do not use frozen materials or materials containing ice or snow.
5. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
6. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators.

H. Hot-Weather Placement: Comply with ACI 305 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is included in total amount of mixing water. Using liquid

nitrogen to cool concrete is contractor's option, but liquid nitrogen should not replace water.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.2 Concrete Wall Finishes

A. Type W-1 (Ordinary Wall Finish):

1. Patch tie holes.
2. Knock off projections.
3. Patch defective areas.

B. Type W-2 (Smooth Wall Finish):

1. Patch tie holes.
2. Grind off projections, fins, and rough spots.
3. Patch defective areas and repair rough spots resulting from form release agent failure or other reasons to provide smooth uniform appearance.

C. Type W-3 (Smooth-Rubbed Finish)

1. Patch tie holes.
2. Grind off projections, fins, and rough spots.
3. Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Type W-5 (Finish for Painting or Coating):

1. Patch tie holes.
2. Grind off projections, fins, and rough spots.
3. Patch and repair defective areas as specified for Type W-2.
4. Apply paint or coating system as specified in Section 09 90 15 - Paints and Coatings.

3.3 Concrete Slab Finishes

A. General:

1. Finish slab concrete per the requirements of ACI 302.1R
2. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
3. Do not use "Jitterbugs" or other special tools designed for the purpose of forcing coarse aggregate away from the surface and allowing a layer of mortar.
4. Do not dust surface with dry materials.
5. Use evaporation retardant.

B. Type S-1 (Steel Troweled Finish):

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation, use evaporation retardant.
2. While concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, wood float to true, even plane with no coarse aggregate visible.
3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
5. Final troweling shall produce a ringing sound from trowel.
6. Do not use dry cement or additional water during troweling.
7. Power Finishing:
 - a. An approved power machine may be used in lieu of hand finishing in accordance with directions of machine manufacturer.
 - b. Do not use power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.
 - c. Do first steel troweling for slab S-1 finish by hand.

C. Type S-2 (Wood Float Finish):

1. Finish slabs to receive fill and mortar setting beds by screeding with straight edges to bring surface to required finish plane.
2. Wood float finish to compact and seal surface.

3. Remove laitance and leave surface clean.
 4. Coordinate with other finish procedures.
- D. Type S-3 (Underside Elevated Slab Finish): When forming is removed, grind off projections on underside of slab and patch defective areas, including small shallow air pockets where schedule of concrete finishes requires painting or protective coating.
- E. Type S-5 (Broomed Finish):
1. Finish as specified for Type S-1 floor finish, except omit final troweling and finish surface by drawing a fine-hair broom lightly across the surface.
 2. Broom in same direction and parallel to expansion joints, or, in the case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.

3.4 Schedule of Concrete Finishes

- A. Form Tolerances: As specified in Section 03 11 00 - Concrete Formwork.
- B. Provide concrete finishes as scheduled:

Area	Type of Finish	Required Form Tolerances
EXTERIOR WALL SURFACES		
Above grade/exposed (above a point 12" below finish grade)	W-3	W-B
Backfilled (below a point 12" below final grade)	W-1	W-A
INTERIOR WALL SURFACES		
Hydraulic Structures and piping galleries	W-3	W-A
Interior surface of walls in containment area	W-5	W-A
Buildings and other dry areas	W-3	W-B
EXTERIOR SLABS		
Exposed Roof slab or Slab-on-grade for non-hydraulic structures	S-5	
Roof slab or Top of Wall for Hydraulic Structures	S-1	
Other water holding tanks and basins	S-1	
Stairs and landings	S-5	
Other exterior slabs/pads	S-1	
Top surfaces of basins in which raking mechanisms are to be installed	S-6	
INTERIOR SLABS		
Non-Hydraulic areas such as pipe galleries and slabs-on-grade	S-1	

Area	Type of Finish	Required Form Tolerances
Underside of elevated slabs	S-3	

3.5 Concrete Protecting and Curing

- A. General: Contractor shall submit a schedule and sequence of concrete placement to the Engineer for review. See 03 11 00 - Concrete Formwork for additional requirements.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
 3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.6 Repairing Concrete

A. General:

1. Any defective areas or areas considered to be structurally deficient shall be removed to the extents required by the Engineer. The Engineer has the option of calling for the removal of the entire section, if the damage is such that a repair will not be a suitable option. All work required to correct the defect will be the responsibility of the Contractor and will be paid for by the Contractor.
2. Repair concrete surfaces defects, as defined by Defective Areas, using one of the materials specified in Section 03 01 00 - Concrete Surface Repair Systems.
3. Develop repair techniques with material manufacturer.
4. Dress surface of repair that will remain exposed to view to match color and texture of adjacent surfaces.

B. Tie Holes:

1. Fill with nonshrink grout.
2. Match color of adjacent concrete.
3. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

C. Alternate Form Ties-Through-Bolts:

1. Seal through-bolt hole by sandblasting or mechanically cleaning and roughening entire interior surface of hole, coating roughened surface with bonding agent.
2. Install elastic vinyl plug according to manufacturer's instructions.
3. Dry pack entire hole on each side of plug with non-shrink grout.
4. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

D. Exposed Metal Objects:

1. Metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, shall be removed by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
2. Repair areas of chipped-out concrete per requirements of Section 03 01 00 - Concrete Surface Repair Systems.

E. Blockouts at Pipes or Other Penetrations:

1. Meet details shown or submit proposed blockouts for review.
2. Use non-shrink, nonmetallic grout.

3.7 Field Quality Control

A. Testing and Inspecting: Owner will engage a qualified testing and inspection agency to perform field tests and inspections and prepare test reports. Payment of the testing and inspection agency shall be by the Contractor from the contract allowance for independent testing in accordance with contract documents.

B. Inspections:

1. Steel reinforcement placement.
2. Cast-in-Place bolts, plates, and headed studs.
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.
6. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture, plus one sample for each additional 50 cu. yd. or fraction thereof.
2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C173/C173M, pressure method, for normal-weight concrete; one test for each composite sample.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below, and when 80 deg F and above.
5. Compression Test Specimens: ASTM C31/C31M.
 - a. Cast three sets of two 6"x12" cylinder specimens (or three sets of three 4"x8" cylinder specimens) for each composite sample.
 - 1) All cylinders shall be laboratory-cured in accordance with ASTM requirements.

6. Compressive-Strength Tests: ASTM C39/C39M
 - a. Test one set of cylinders at 7 days and one set cylinders at 28 days. The additional set of cylinders will be retained for subsequent testing, as required by the Engineer.
 - b. A compressive-strength test shall be the average compressive strength from a set of two 6"x12" specimens (or a set of three 4"x8" specimens) obtained from the same composite sample and tested at age indicated.
7. Acceptance of concrete strength for the mix design shall be based on compressive strength results for 28-day tests. Acceptance of the concrete strength for the mix design shall be determined in accordance with ACI 318 requirements.
8. Strength of each individual concrete sample will be satisfactory if the average of the set for the 28-day compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
9. Test results shall be reported in writing to Engineer, Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, placement of concrete batch in Work, design compressive strength at 28 days, concrete mixture identification, slump test results, air content test results, and compressive strength test results.
10. Additional testing and inspection, will be performed, as required by the Engineer and at Contractor's expense, when test results indicate requirements have not been met.
 - a. The third set of cylinders may be broken at a concrete age as specified by the Engineer.
 - b. Testing and inspection agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods, as directed by Engineer.
 - c. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive devices may be permitted by Engineer.
11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

- D. Measure floor and slab flatness and levelness according to ASTM E 1155 48 hours after finishing. Specified overall values of flatness $F(f)=25$; and levelness $F(L)=20$; with minimum local values, $F(f)=17$ and $F(L)=15$.
1. $F(L)$ value only applies to elevated slabs after shoring has been removed.

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Shelf angles.
4. Loose bearing and leveling plates.
5. Steel welded plates and angles for casting into concrete not specified in other Sections.
6. Miscellaneous steel trim including steel angle corner guards and steel edgings.
7. Metal ladders.
8. Metal bollards.
9. Pipe guards.
10. Metal floor plate and supports.
11. Abrasive metal nosing, treads, and thresholds.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to

excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

- a. Section 03 30 00 - Cast-in-Place Concrete.
- b. Section 05 53 00 - Metal Gratings.
- c. Section 09 90 15 - Paints and Coatings.

1.2 Performance Requirements

- A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- B. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 °F, ambient; 180 °F, material surfaces.

1.3 Submittals

- A. Product Data: For the following:
 - 1. All miscellaneous metals required for the work.
 - 2. Paint products required as a part of the work for this section.
 - 3. Concrete anchors.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 2. Provide templates for anchors and bolts specified for installation under other Sections.
 - 3. For installed products which are indicated as a delegated design item, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Verification: For each type and finish of extruded nosing and tread.
- D. Mill Certificates: Signed by Manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
- E. Welding certificates.

1.4 Quality Assurance

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.6, "Structural Welding Code--Stainless Steel."

1.5 Project Conditions

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.6 Coordination

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

Part 2 Products

2.1 Manufacturers

- A. In other Part 2 Articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 Metals, General

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Ferrous Metals
 1. Steel Plates, Shapes, and Bars: ASTM A 36.
 2. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304 or 316.
 3. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 or 316.
 4. Steel Tubing: ASTM A 500, cold-formed steel tubing.
 5. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
 6. Cast Iron: ASTM A 48, Class 30, unless another class is indicated or required by structural loads.
- C. Nonferrous Metals
 1. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.
 2. Aluminum Extrusions: ASTM B 221, Alloy 6061-T6.
 3. Aluminum-Alloy Rolled Tread Plate: ASTM B 632, Alloy 6061-T6.
 4. Aluminum Castings: ASTM B 26, Alloy 443.0-F.

2.3 Fasteners

- A. General: Unless otherwise indicated, provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563; and, where indicated, flat washers.
 1. Finish: Plain or Hot Dip Zinc-coated ASTM A153 Class C, as indicated.

- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593, AISI Type 316, Condition CW for bolts and ASTM F 594 for AISI Type 316, Condition CW nuts.
 - 1. All threads on stainless steel rods/bolts shall be protected with anti-seize lubricant suitable for submerged stainless bolts and complying with Federal Specification MIL-A-907E.
- D. Anchor Bolts: ASTM F 1554, Grade 36, unless noted otherwise on the drawings.
 - 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
- E. Machine Screws: ASME B 18.6.3.
- F. Lag Bolts: ASME B 18.2.1.
- G. Wood Screws: Flat head, ASME B18.6.1.
- H. Plain Washers: Round, ASME B 18.22.1.
- I. Lock Washers: Helical, spring type, ASME B 18.21.1.
- J. Cast-in-Place Anchor Rods: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. ASTM F1554 (grade as indicated on the drawings) threaded or wedge type; galvanized ferrous castings either ASTM A 47 malleable iron or ASTM A 27, cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153.
- K. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Basis of Design equal to: Hilti Kwik Bolt TZ
 - a. If the contractor chooses to submit an anchor other than that listed as the basis of design, then the contractor is responsible for providing adequate documentation to prove that the submitted anchor meets or exceeds the design capacity of the anchor specified and is ICC certified.
 - 2. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 3. Material for Anchors in Exterior Locations: ASTM F 593, AISI Type 316, Condition CW for bolts and ASTM F 594 for AISI Type 316, Condition CW nuts.

4. Expansion anchors shall not be substituted for adhesive anchors.

L. Adhesive Anchors:

1. Threaded Rod:

- a. ASTM F 593 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.
- d. For hollow-unit masonry, provide galvanized or stainless steel wire cloth screen tube to fit threaded rod.

2. Adhesive:

- a. Basis of Design equal to: Hilti HIT-HY 200
 - 1) If the contractor chooses to submit an anchor other than that listed as the basis of design, then the contractor is responsible for providing adequate documentation to prove that the submitted anchor meets or exceeds the design capacity of the anchor specified and is ICC certified.
- b. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments, with gray color after mixing.
- c. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
- d. Non-sag, with selected viscosity based on installation temperature and overhead application where applicable.

3. Packaging:

- a. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
- b. Cartridge Marking: Include manufacturer's name, product name, material type, batch serial number, and adhesive expiration date.

2.4 Miscellaneous Materials

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 9.

- C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.
 - 1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.), or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- D. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat specified in Section 09 90 15.
 - 1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.), or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 Fabrication, General

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32", unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips

flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure, and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.6 Miscellaneous Framing and Supports

- A. General: Design and provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts if units are installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 Loose Steel Lintel

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8", unless otherwise indicated.
- C. Provide galvanized loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in interior walls with zinc-rich primer.

2.8 Loose Bearing and Leveling Plates

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

- B. Galvanize plates after fabrication.
- C. Prime plates with zinc-rich primer.

2.9 Steel Weld Plates and Angles

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.10 Miscellaneous Steel Trim

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.
- D. Prime interior miscellaneous steel trim, with zinc-rich primer.

2.11 Metal Ladders

- A. General:
 - 1. Comply with the more stringent requirements of OSHA and ANSI A14.3, unless indicated otherwise.
 - 2. Space side rails 18" clear minimum, unless otherwise indicated.
 - 3. Support each ladder at top and bottom and not more than 60 inches o.c, with welded or bolted brackets, made from same metal as ladder.
 - 4. All ladders, including ladders less than 20 feet in height, shall be equipped with an integral fall protection system.
- B. Extension (Pop-up). Every ladder that does not have an exterior hand hold shall be equipped with a pop-up extension designed by the ladder manufacturer.
 - 1. Pop-up extension shall be of the same material and finish as the ladder with telescoping tubular section that locks automatically when fully extended.
 - 2. Upward and downward movement shall be controlled by stainless steel spring balancing mechanisms.

3. Units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's recommendations.

C. Fall Prevention System (Ladder):

1. All ladders, including ladders less than 20 feet in height, shall be equipped with an integral fall prevention system. The fall prevention system at each ladder shall include a permanent metal carrier rung/rail, carrier rung/rail extension as required, sliding sleeve arresting unit, ladder rung clamps, full body harness, dismount section and all other components as necessary for complete installation and system to comply with OSHA and ANSI A14.3 standards and requirements.
 - a. The fall prevention system manufacturer shall design each fall prevention system, coordinate with the ladder manufacturer and submit the fall prevention system design and detailed plans to the Engineer for approval.
 - b. The carrier rung/rail shall be Type 316 stainless steel or aluminum alloy 6105-T5.
 - c. Carrier rung/rail extensions shall be provided for safe ladder access and egress. The total carrier rung/rail length shall be as designed by the fall prevention system manufacturer.
 - d. Manufacturers equal to:
 - 1) Sellstorm Manufacturing.
 - 2) North Safety Products, Ltd.

D. Steel Ladders:

1. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.
2. Rung spacing shall not exceed 12 inches on center.
3. Provide non-slip surfaces on top of each rung by coating with abrasive material metallically bonded to rung by a proprietary process.
4. Products equal to:
 - a. IKG Industries, a Harsco company; Mebac.
 - b. W. S. Molnar Company; SlipNOT.
5. Galvanize exterior ladders and interior ladders, unless indicated otherwise, including brackets and fasteners.

E. Aluminum Ladders:

1. Fit rungs in centerline of side rails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.
2. Rung spacing shall not exceed 12 inches on center.
3. Provide non-slip surfaces on top of each rung by coating with abrasive material metallically bonded to rung by a proprietary process.
4. Products equal to:
 - a. IKG Industries, a Harsco company; Mebac.
 - b. W. S. Molnar Company; SlipNOT.

2.12 Metal Floor Plate

- A. Also referenced as "Checkered" or "Check" Plate, with raised lugs on one side and smooth surface on other side.
- B. Fabricate from roller-aluminum-alloy 6061-T6, ASTM B 632 plate of thickness indicated below. Raised lug pattern shall be on top and start at 45° angle to edge of plate or tread.
- C. Provide stainless steel or aluminum angle stiffeners and/or aluminum beam supports, as indicated or required.
- D. Provide flush stainless steel bar drop handles for lifting removable sections. Provide one at each end of each section.
- E. All ends and openings shall be banded and sealed with a 1/4-inch neoprene gasket.
- F. The weight of a floor plate section shall not exceed 150 pounds.
- G. Aluminum surfaces in contact with concrete, grout or dissimilar metals will be protected with a coat of bituminous paint, Mylar isolators or other protective system, as approved by the Engineer.
- H. Manufacturers equal to:
 1. Thompson Fabricating, LLC; Tarrant, AL.

2.13 Metal Bollards

- A. Fabricate metal bollards from 6" diameter steel pipe and fill with non-structural concrete. Refer to drawings and standard details for locations and anchorage details.
- B. Paint exposed portions of pipe with an OSHA safety yellow paint.

2.14 Abrasive Metal Nosings and Treads

- A. Cast-Metal Units: Cast aluminum, with an integral abrasive finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in sizes and configurations indicated and in lengths necessary to accurately fit openings or conditions.
1. Manufacturers equal to:
 - a. American Safety Tread Co., Inc.
 - b. Baleo Inc.
 - c. Barry Pattern & Foundry Co., Inc.
 - d. Granite State Casting Co.
 - e. Safe-T-Metal Co.
 - f. Wooster Products Inc.
 2. Nosing: Cross-hatched units, 4 inches wide with ¼ inch lip, for casting into concrete steps.
 3. Nosing: Cross-hatched units, 1-1/2 inch by 1-1/2 inch, for casting into concrete curbs.
 4. Treads: Cross-hatched units, full depth of tread with 3/4inch by 3/4inch nosing, for application over bent plate treads or existing stairs.
- B. Extruded Units: Aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in sizes and configurations indicated and in lengths necessary to accurately fit openings or conditions.
1. Manufacturers equal to:
 - a. ACL Industries, Inc.
 - b. American Safety Tread Co., Inc.
 - c. Amstep Products.
 - d. Armstrong Products, Inc.
 - e. Baleo Inc.
 - f. Granite State Casting Co.
 - g. Wooster Products Inc.

2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
 3. Provide solid-abrasive-type units without ribs.
 4. Nosing: Square-back units, 3 inches wide, for casting into concrete steps.
 5. Nosing: Beveled-back units, 3 inches wide with 1-3/8 inch lip, for surface mounting on existing stairs.
 6. Nosing: Two-piece units, 3 inches wide, with sub channel for casting into concrete steps.
 7. Treads: Beveled-back units, full depth of tread with 1-3/8 inch lip, for application over existing stairs.
- C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with Manufacturer.
- D. Drill for mechanical anchors and countersink. Locate not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by Manufacturer.
1. Provide 2 rows of holes for units more than 5 inches wide, with 2 holes aligned at ends and intermediate holes staggered.
- E. Apply bituminous paint, Mylar isolators or other protective system as approved by the Engineer to concealed bottoms, sides, and edges of cast-metal units set into concrete

2.15 Finishes, General

- A. Comply with NAAMM "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly according to the paintings and protective coatings specification.

2.16 Steel and Iron Finishes

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
1. ASTM A 123 for galvanizing steel and iron products.
 2. ASTM A 153 for galvanizing steel and iron hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich primer: SP 6/NACE
- C. No.3, "Commercial Blast Cleaning."
 1. 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- D. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No.1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.17 Stainless-Steel Finishes

- A. Remove tool and die marks and stretch lines or blend into finish.
- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- C. Bright, Directional Satin Finish: No.4.
- D. Dull Satin Finish: No.6.
- E. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.18 Aluminum Finishes

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).
- C. Class 1, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class 1, clear coating 0.018 mm or thicker) complying with AAMA 611.

Part 3 Execution

3.1 Installation, General

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded

because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 Installing Miscellaneous Framing and Supports

- A. General: Install framing and supports to comply with requirements of items being supported, including Manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

3.3 Installing Bearing and Leveling Plates

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use non-shrink grout, nonmetallic, in concealed locations where not exposed to moisture; use non-shrink, nonmetallic grout in exposed locations, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 Installing Metal Bollards

- A. Anchor bollards in concrete as indicated on the drawings.
- B. Anchor bollards in place with non-structural concrete, as indicated on the drawings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- C. Fill bollards solidly with concrete, mounding top surface to shed water.
 1. Do not fill removable bollards with concrete.

3.5 Installing Nosings, Treads, and Thresholds

- A. Center nosing on tread widths.
- B. For nosing embedded in concrete steps or curbs, align nosing flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant to provide a watertight installation.

3.6 Adjusting and Cleaning

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Apply by brush or spray to provide a minimum 2.0 mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Metal gratings.
2. Prefabricated heavy-duty carbon steel bar gratings.
3. Miscellaneous installation hardware and accessories.

B. Related Sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. 05 50 00 - Metal Fabrications, for supporting beams and frame work.
 - b. 09 90 15 - Paints and Coatings, for protective coatings and coatings for dissimilar metals in contact.

1.2 General Requirements

- A. Contractor, and/or sub-contractor, is responsible for field verifying all grating and plank locations, dimensions, obstructions, openings, and any other pertinent coordination issues prior to bidding. For existing items marked to be reused, contractor is responsible for field verifying existing condition and determining whether replacement is required prior to bidding.

1.3 Submittals

A. Shop Drawings:

1. Include plans, elevations, sections, details, supports and attachment to other work.
2. Grating: Show dimensions, weight, and location of connections to adjacent grating, supports, and other Work.

3. Grating Supports: Show dimensions, size, location, and anchorage to supporting structure.
 4. Catalog information and catalog cuts.
 5. Manufacturer's specifications, to include coatings.
- B. Quality Control Submittals:
1. Special handling and storage requirements.
 2. Installation instructions.
 3. Factory test reports.
 4. Manufacturer's Certification of Compliance for specified products.
 5. Written Test Report that swaged crossbars, if used on grating, meet the requirements of the specified test and additional requirements of these Specifications.

1.4 References

- A. The following is a list of standards which may be referenced in this section:
1. American Society for Testing and Materials (ASTM):
 - a. A 36, Standard Specification for Structural Steel.
 - b. A 123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. A 153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware (R 1987).
 - d. A 167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - e. A 193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - f. A 194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
 - g. A 307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - h. A 525, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
 - i. A 569/A569M, Standard Specification for Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.

- j. B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
- k. F 844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
- 2. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. ANSI MBG 531, Metal Bar Grating Manual.
 - b. ANSI MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.5 Preparation for Shipment

- A. Insofar as is practical, factory-assemble items to insure proper fit before shipping to job site.
- B. Package and clearly tag parts and assemblies that are of necessity shipped un-assembled and protect the materials from damage and facilitate identification and final assembly in the field.

Part 2 Products

2.1 Foot Traffic Grating

- A. Size & Type: As indicated on the drawings.
- B. Weight: No section shall weigh more than 150 pounds.
- C. Material: As indicated on the drawings.
 - 1. Galvanized Steel Bar Type Grating: Welded crossbar design.
 - a. Thompson Fabricating, LLC, Tarrant, AL.
 - b. Ohio Gratings, Inc., Canton.
 - 2. Aluminum I-Bar Type Grating: Pressure locked crossbar design.
 - a. Thompson Fabricating, LLC, Tarrant, AL.
 - b. Ohio Gratings, Inc., Canton.

2.2 Heavy-Duty Metal Bar Grating

- A. Size & Type: As indicated on the drawings.
- B. Weight: No section shall weigh more than 150 pounds.
- C. Material: As indicated on the drawings.

1. Main Bearing bars and rectangular cross bars are to be type ASTM Grade - 36 Carbon Steel. Round Cross bars are to be per ASTM A-510. Banding is to be Carbon Steel type ASTM Grade -36.
- D. Finish: Gratings shall be Hot-Dip Galvanized per ASTM A123.
- E. Manufacturers:
 1. Ohio Gratings, Inc., Canton.
 2. Or approved equal.

2.3 Accessories

- A. Anchor Bolts and Nuts:
 1. Stainless Steel: ASTM A193 and ASTM A194, Type 316.
 2. Galvanized Steel Bolts and Nuts: ASTM A153, zinc coating for ASTM A307 or A36.
- B. Flat Washers (Unhardened): ASTM F844; use ASTM A153 for zinc coating.
- C. Removable Fastener Clips and Bolts:
 1. Removable from above grating walkway surface.
 2. Material: To match Grating material.
 3. Type(s):
 - a. Saddle clips.
 - b. Z clips.
 - c. Countersunk.

2.4 Fabrication

- A. General:
 1. Exposed Surfaces: Smooth finish and sharp, well-defined lines.
 2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in a neat, substantial manner.
 3. Conceal fastenings where practical.
 4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
 5. Weld Connections: Not permitted on grating except at banding bars.

B. Sizing:

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 falling down through clear opening when oriented in the span direction when one end is touching either the concrete or the vertical leg of grating support.
3. Minimum Bearing: ANSI/NAAMM MBG 531.
4. Metal Crossbar Spacing: 4 inch maximum, unless otherwise shown or specified.
5. Banding: All ends to be banded with same material as grating or plank; ANSI/NAAMM MBG 531 and ANSI/NAAMM MBG 532.
6. Furnish stainless steel Type 316 threaded anchor studs, as fasteners for grating attachment to metal supports either not embedded or partially embedded in concrete.

C. Supports:

1. Embed frames, angles, and beams where shown on the drawings:
 - a. Material: To match grating.
2. Coordinate dimensions and fabrication with grating or plank to be supported.
3. Welded Frames with Anchors: Continuously welded.

D. Slip-Resistant Surface:

1. I-Bar grating shall incorporate a striated antiskid walking surface, as manufactured by:
 - a. Thompson Fabricating, LLC, Tarrant, AL.
 - b. Ohio Gratings, Inc., Canton,

Part 3 Execution

3.1 Preparation

A. Electrolytic Protection:

1. Aluminum in contact with dissimilar metals, other than stainless steel, or in contact with masonry, grout, or concrete shall be coated with a bituminous coating as specified in Section 09 90 15 – Paint.
2. Allow paint to dry before installation of the material.

3.2 Installation

- A. Install supports such that grating sections have a solid bearing on both ends, and that rocking or wobbling movement does not occur under designed traffic loading.
- B. Install plumb or level as applicable.
- C. Install welded frames with anchors to straight plane without offsets.
- D. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.
- E. Use stainless steel anchors and accessories with aluminum gratings.
- F. Completed installation shall be rigid and neat in appearance.
- G. Wherever grating is pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a rectangular band bar of the same height and material as bearing bars.
- H. Cutouts for circular openings are to be 2 inches larger in diameter than the obstruction. Cutouts for all piping 4 inches or less shall be made in the field.
- I. All rectangular cutouts are to be made to the next bearing bar beyond the penetration with a clearance not to exceed bearing bar spacing.
- J. Commercially Manufactured Products:
 - 1. Install in accordance with Manufacturer's recommendations.
 - 2. Secure grating or plank to support members with fasteners.
 - 3. Fasteners: Field locate and install.
 - 4. Permit each grating section or plank style grating assembly to be easily removed and replaced.
- K. Protect all painted surfaces during installation.
- L. Should coating become marred, prepare and touch up surface in accordance with paint Manufacturer's instructions.

END OF SECTION

Part 1 General

1.1 Work Included

- A. Surface preparation.
- B. Field application of paints and other coatings.
- C. Materials for back-priming woodwork.
- D. Scope: All interior and exterior surfaces of the existing Dewatering Building, Truck Loading Station, and open-air shelter that are currently coated and exposed to view are to be recoated, including, but not limited to: building structural steel, precast concrete wall panels, CMU walls, underside of roof decking or insulation, piping and piping accessories, drywall, electrical conduit, mechanical equipment, and various storage cabinets. All new components exposed to view are to be painted, unless fully factory-finished or unless otherwise indicated, including the following:
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Mechanical and Electrical:
 - a. Paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. Paint shop-primed items.
- E. Do Not Paint or Finish the Following New Items:
 - 1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne, and lead items.
 - 6. Glass.
 - 7. Concealed pipes, ducts, and conduits.
 - 8. Operating parts or machined surfaces.

1.2 Definitions

- A. Conform to ASTM D16 for interpretation of terms used in this section.

1.3 Submittals

- A. See Section 01 33 00 – Submittal Procedures for submittal procedures.
- B. Product Data: Provide data on all finishing products, including VOC content.
- C. Samples: Submit two paper chip samples, 3" x 5" inch (76.2 x 127 mm) in size illustrating range of colors and textures available for each surface finishing product scheduled.
- D. Paint Schedule: Provide list, by process area or building, of all surfaces to be coated, with selected coating system identified. Where required colors are identified in other Sections, provide color chart and identify required colors on paint schedule. Where required colors are not identified, leave space for Owner to provide selected color.
- E. Piping Identification layout and colors.
- F. Certificates
 - 1. Applicator's Qualifications.
 - 2. Qualification Testing laboratory for coatings.
 - 3. Indoor Air Quality data for Paints and Primers.
 - a. For occupied indoor spaces, provide paint and coating products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification documentation from certification body.
- G. Manufacturer's Instructions
 - 1. Application Instructions: Indicate special surface preparation procedures.
 - 2. Mixing: Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.
 - 3. Manufacturer's Safety Data Sheets.
- H. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 78 43 - Spare Parts and Special Tools, for additional provisions.
2. Extra Paint and Coatings: 1 gallon (4 L) of each color; store where directed.
3. Label each container with color in addition to the manufacturer's label.

1.4 Quality Assurance

- A. Required Standards: Coatings subcontractor shall have and maintain on-site during all coating operations the proper industrial standards for use by the Owner or Owner's representative. Industrial standards to be maintained on-site include:
 1. SSPC (Structural Steel Painting Council) Steel Structures Painting Manual, Volume 1.
 2. SSPC-VIS-1 - Pictorial Surface Preparation Standards for Painting Steel Surfaces.
- B. Required Inspection Tools: Coatings subcontractor shall have and maintain on-site during all coating operations the proper industrial paint inspection tools for use by the Owner or Owner's representative. Inspection tools to be maintained on-site shall include, as appropriate:
 1. Sling psychrometer kit.
 2. Testex tape kit.
 3. Zahn Cups Nos. 2, 3, 4 and 5 with a thermometer for air spray paint.
 4. Nordsen Mikrotest or equal wet mil gauge.
 5. National Bureau of Standard Calibration Chips.
 6. Took Gauge.
 7. Elcometer 10612 Pull Off Adhesion gauge with aluminum dollies and epoxy glue.
- C. Contractor shall obtain, from the supplier/manufacture, material safety data sheets (MSDS) for all products, as well as any other special handling, application and cleanup precautions or recommendations. Contractor shall be responsible to follow these safety recommendations and precautions.
- D. Single Source Responsibility: Provide primers and other undercoat paint produced by the same manufacturer as finish coats. Use only thinner approved by paint manufacturer, and use only within recommended limits.
- E. NSF Approval: All coating materials in contact with potable water shall comply with ANSI/NSF Standards 61, latest revision.

1.5 Qualifications

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years' experience in utility applications. The paints and paint products mentioned in the following specifications are set up as standards of quality. No request for substitution will be considered which decreases the film thickness and/or the number of coats to be applied, or which offers a change from the generic type of coating specified.
- B. Applicator's Qualifications:

SSPC QP 1 Certification: All contractors and subcontractors that perform surface preparation or coating application must be certified by the Society for Protective Coatings (formerly Steel Structures Painting Council) (SSPC) to the requirements of SSPC QP 1 prior to contract award, and must remain certified while accomplishing any surface preparation or coating application. If a contractor's or subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply.

1.6 Regulatory Requirements

- A. Environmental Protection
 - 1. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local or regional jurisdiction. Notify Engineer of any paint specified herein which fails to conform.
- B. Lead Content: Do not use coatings having a lead content over 0.06 percent by weight of non-volatile content.
- C. Chromate Content: Do not use coatings containing zinc-chromate or strontium-chromate.
- D. Asbestos Content: Provide asbestos-free materials.
- E. Mercury Content: Provide materials free of mercury or mercury compounds.
- F. Silica: Provide abrasive blast media containing no free crystalline silica.
- G. Human Carcinogens: Provide materials that do not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.7 Delivery, Storage, and Handling

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.
- D. Furnish pigmented paints in containers not larger than five gallons.
- E. Do not store paint, polyurethane, varnish, or wood stain products with materials that have a high capacity to adsorb VOC emissions. Do not store paint, polyurethane, varnish, or wood stain products in occupied spaces.

1.8 Field Conditions

- A. Coatings shall be applied during good painting weather. Air and surface temperatures shall be within limits prescribed by the manufacturer for the coating being applied and work areas shall be reasonably free of airborne dust at the time of application and while coating is drying.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

1.9 Coordination

- A. Coordinate work under provisions of Division 1.
- B. Coordination of Work: review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

Part 2 Products

2.1 Materials

- A. All materials specified herein shall be as manufactured by:
 - 1. TNEMEC Co., Inc., North Kansas City, Missouri.
 - 2. The Sherwin-Williams Company, Cleveland, Ohio.
- B. Colors, where not specified, shall be as selected by the A/E from the paint manufacturer's color chart. All colors shall be certified lead free.

1. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling they are mounted on/under.
2. In utility areas, finish equipment, piping, conduit, and exposed duct work in colors according to the color coding scheme indicated.

2.2 Paints and Coatings - General

- A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
 1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 3. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 4. Supply each coating material in quantity required to complete entire project's work from a single production run.
 5. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Volatile Organic Compound (VOC) Content: Provide coatings that comply with the most stringent requirements specified in the following:
 1. Local or state regulations
 2. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings.
 3. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

Part 3 Execution

3.1 Examination

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.
- D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - 2. Concrete Floors and Traffic Surfaces: 8 percent.

3.2 Protection of Areas and Spaces Not to be Painted

- A. Prior to surface preparation and coating applications, remove, mask, or otherwise protect hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated.
- B. Following completion of painting, reinstall removed items by workmen skilled in the trades.
- C. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

3.3 Surface Preparation

- A. Clean surfaces thoroughly and correct defects prior to coating application.
 - 1. Remove dirt, splinters, loose particles, grease, oil, disintegrated coatings, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments.
 - 2. Remove oil and grease prior to mechanical cleaning.
- B. Schedule cleaning so that dust and other contaminants will not fall on wet, newly painted surfaces. Spot-prime exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

- C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

- D. Additional Requirements for Preparation of Surfaces With Existing Coatings

- 1. Before application of coatings, perform the following on surfaces covered by soundly-adhered coatings, defined as those which cannot be removed with a putty knife:

- a. Test existing finishes for lead before sanding, scraping, or removing. If lead is present, refer to paragraph Toxic Materials.

- b. Wipe previously painted surfaces to receive solvent-based coatings, except stucco and similarly rough surfaces clean with a clean, dry cloth saturated with mineral spirits, ASTM D235. Allow surface to dry.

- Wipe immediately preceding the application of the first coat of any coating, unless specified otherwise.

- c. Sand existing glossy surfaces to be painted to reduce gloss. Brush, and wipe clean with a damp cloth to remove dust.

- d. Thoroughly clean previously painted surfaces specified to be repainted of all grease, dirt, dust or other foreign matter.

- e. Remove blistering, cracking, flaking and peeling or otherwise deteriorated coatings.

- f. Remove chalk so that when tested in accordance with ASTM D4214, the chalk resistance rating is no less than 8.

- g. Roughen slick surfaces. Repair damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls with suitable material to match adjacent undamaged areas.

- h. Feather and sand smooth edges of chipped paint.

- i. Clean rusty metal surfaces as per SSPC requirements. Use solvent, mechanical, or chemical cleaning methods to provide surfaces suitable for painting.

- j. Provide new, proposed coatings that are compatible with existing coatings.

- E. Existing Coated Surfaces with Minor Defects

- 1. Sand, spackle, and treat minor defects to render them smooth. Minor defects are defined as scratches, nicks, cracks, gouges, spalls, alligating, chalking, and irregularities due to partial peeling of previous coatings.

F. Removal of Existing Coatings

1. Remove existing coatings from the following surfaces:
 - a. Surfaces containing large areas of minor defects;
 - b. Surfaces containing more than 20 percent peeling area; and
 - c. Surfaces designated by the Engineer, such as surfaces where rust shows through existing coatings.

3.4 Preparation of Metal Surfaces

- A. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to requirements of painting schedule. Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.
- B. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with painting schedule.
- C. Ductile Iron Pipe with Existing Coatings: Existing ductile iron pipes to be recoated shall have existing coating removed by abrasive blast cleaning in accordance with NAPF 500-03-04 for pipe and NAPF 500-03-05 for fittings.
- D. Final Ferrous Surface Condition:
 1. For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. Use as a visual reference, photographs in SSPC VIS 3 for the appearance of cleaned surfaces.
 2. For abrasive blast cleaned surfaces, the requirements are stated in SSPC 7/NACE No.4, SSPC SP 6/NACE No.3, and SSPC SP 10/NACE No. 2. Use as a visual reference, photographs in SSPC VIS 1 for the appearance of cleaned surfaces.
 3. For waterjet cleaned surfaces, the requirements are stated in SSPC SP WJ-4. Use as a visual reference, photographs in SSPC VIS 4/NACE VIS 7 for the appearance of cleaned surfaces.
- E. Non-Ferrous Metallic Surfaces
 1. Aluminum and aluminum-alloy, lead, copper, and other non-ferrous metal surfaces.
 - a. Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

2. Terne-Coated Metal Surfaces

- a. Solvent clean surfaces with mineral spirits, ASTM D235. Wipe dry with clean, dry cloths.

F. Existing Surfaces with a Bituminous or Mastic-Type Coating

1. Remove chalk, mildew, and other loose material by washing with a solution of 1/2 cup trisodium phosphate, 1/4 cup household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water.

3.5 Preparation of Concrete and Cementitious Surface

A. Concrete and Masonry

1. Curing: Allow concrete, stucco and masonry surfaces to cure at least 30 days before painting, and concrete slab on grade to cure at least 90 days before painting.
2. Surface Cleaning: Remove the following deleterious substances.
 - a. Dirt, Grease, and Oil: Wash new and existing uncoated surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water.[Wash existing coated surfaces with a suitable detergent and rinse thoroughly.] For large areas, water blasting may be used.
 - b. Fungus and Mold: Wash new, existing coated, and existing uncoated surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, 1 quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.
 - c. Paint and Loose Particles: Remove by wire brushing.
 - d. Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.
3. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.

B. Gypsum Board, Plaster, and Stucco

1. Surface Cleaning: Verify that plaster and stucco surfaces are free from loose matter and that gypsum board is dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to

application of the first coat material. A damp cloth or sponge may be used if paint will be water-based.

2. Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.
3. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. Do not apply epoxies to damp surfaces as determined by ASTM D4263. Verify that new plaster to be coated has a maximum moisture content of 8 percent, when measured in accordance with ASTM D4444, Method A, unless otherwise authorized. In addition to moisture content requirements, allow new plaster to age a minimum of 30 days before preparation for painting.

3.6 Materials Preparation

- A. Mix and prepare painting materials in accordance with manufacturer's directions.
- B. Maintain containers used in mixing and application of paint in a clean condition free of foreign materials and residue.
- C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
- D. Two-Component Systems: Mix two-component systems in accordance with manufacturer's instructions. Follow recommendation by the manufacturer for any thinning of the first coat to ensure proper penetration and sealing for each type of substrate.

3.7 Application

- A. General: Apply paint in accordance with manufacturer's directions and with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.. Use applicators and techniques best suited for substrate and type of material being applied.
 1. Provide finish coats which are compatible with prime paints used.
 2. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until a paint film is of uniform finish.
 3. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
 4. Paint interior surfaces of ducts, where visible through registers or grilles with flat, non-specular black paint.

5. Paint back sides across panels, and removable or hinged covers to match exposed surfaces.
 6. Finish doors on tops, bottoms, and side edges same as faces.
 7. Sand lightly between each succeeding coat.
 8. No paint shall be applied when the air or surface temperature, as measured in the shade, is above or below that which is recommended by the manufacturer.
 9. Paint shall not be applied to wet or damp surfaces, and shall not be applied in rain, snow, fog, mist or when the surface temperature will be less than 5°F above the dew point.
 10. No paint shall be applied when the air or surface temperature will drop below the manufacturer's recommendation within eight hours after the application of the paint. Dew or moisture condensations should be anticipated, and if such conditions are prevalent, painting shall be delayed until it is certain that the surfaces are dry; further, the day's painting shall be completed well in advance of the probable time of day when the moisture condensation will occur, in order to permit the film the required drying time as specified by the manufacturer prior to the formation of moisture.
 11. Care must be exercised that the coatings are not applied in too heavy a coat above that recommended by the manufacturer and that adequate drying time is permitted between the coats to assure the proper release of solvents.
 12. Mixing, thinning, pot life, application procedure, equipment, coverage, curing, re-coating, storage and number of coats shall be in accordance with coating manufacturer's instructions.
 13. Avoid degradation and contamination of blasted surfaces, and avoid between coat contamination. Surfaces contaminated shall be cleaned before applying next coat. Method of cleaning contaminated surface shall be approved by the Owner or Owner's representative.
 14. Each application of material shall be worked into corners, crevices, joints, etc., and distributed evenly over flat surfaces. Spraying techniques that result in uniform wet pattern shall be used and dry spraying should be avoided. Dry spray shall be removed prior to coating being applied.
 15. All bolts, welds, sharp edges, and difficult access areas shall receive a primer brush coat or spray coat prior to primer spray application.
- B. Scheduling Painting: Apply first coat material to surfaces that have been cleaned, pre-treated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration. Allow sufficient time between successive coating to permit proper drying. Do not re-coat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb

pressure, and application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

- C. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness as recommended by the coating manufacturer.
- D. Prime Coats: Apply prime coat of material which is required to be painted or finished, and which has not been prime coated by others. Re-coat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.
- E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- F. Transparent (Clear) Finishes: Use multiple coats to produce glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes or other surface imperfections.
- G. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.
- H. Workmanship: Workmanship shall be of first class quality. Finish painting shall show no drips, runs, sags, holidays or other defects. The finish coat shall be free from noticeable laps or brush marks. Paint during application shall be continuously stirred and no thinner shall be added after the paint has been mixed. Paint shall be thoroughly worked into all joints, corners, and well brushed out over all surfaces. Should any coat or paint be judged as unsatisfactory, the Contractor shall remove the coat(s) as necessary and repaint at no additional cost to the Owner.

3.8 Clean-up and Protection

- A. Damaged Coatings: Damaged coatings, pinholes, and holidays shall have edges feathered and repaired in accordance with the recommendations of the manufacturer, as approved by the Owner.
- B. All finish coats, including touch up and damage repair coats, shall be applied in a manner which will present a uniform texture and color match appearance.
- C. Unsatisfactory Application: If the item has an improper finish, color or insufficient film thickness, the surface shall be cleaned and top-coated with the specified material to obtain the specified color and coverage. Specific surface preparation information to be secured from the coatings manufacturer and the Owner.
 - 1. All visible areas of chipped, peeled, or abraded paint shall be hand or power-sanded, feathering the edges. The areas shall then be primed and finish coated in accordance with the specifications.

2. Work shall be free of runs, bridges, shiners, laps or other imperfections. Evidence of these conditions shall be cause for rejection.
3. Any defects in the coating system shall be repaired by the Contractor per written recommendations of the coating manufacturer.

D. Guarantee and Anniversary Inspection

1. All work shall be warranted for a period of five (5) years from the date of acceptance of the project.
2. The Owner will notify the Contractor at least 30 days prior to the anniversary date and shall establish a date for the inspection. Any defects in the coating system shall be repaired by the Contractor at no additional cost to the Owner. Should a failure occur to 25% or more of the painted surface, either interior or exterior, the entire surface shall be cleaned and painted in accordance with these specifications.

E. Clean Up

1. All cloths and waste that might constitute a fire hazard shall be placed in closed metal containers or destroyed at the end of each day. Upon completion of the work, all staging, scaffolding, and containers shall be removed from the site and/or destroyed in an approved and legal manner. Paint spots, oil or stains upon adjacent surfaces and floors shall be completely removed, and the entire job left clean and acceptable to the Owner.

3.9 Painting Schedule

A. General:

1. Surfaces not to be Painted:
 - a. Face brick.
 - b. Pre-finished ceiling coverings.
 - c. Concrete floors
 - d. Items with factory applied final finish.
 - e. Concealed ducts, pipes, and conduit.
 - f. Aluminum, except at wall expansion joints.
 - g. Pre-finished equipment items.
 - h. Gaskets and expansion joints in piping system.

2. Shop primer on materials and products is not considered as primer coat under the painting schedule.

B. Painting Schedule

Exposures	Surfaces	System Schedules				
		Concrete & Concrete Block Substrate	Non-Ferrous Metals Substrate	Ferrous Metals Substrate	Wood Substrate	Other Substrate
Interior	Floors		-	-	-	-
	Building Surfaces**	238	-	644		Drywall: 160
	Equipment*	-	114	644	-	
	Piping*		114	644		
	Cloth Cover for Insulation	-			-	160
Exterior Above Grade	Building Surfaces**	238	114	247		-
	Equipment*	-	114	247	-	-
	Piping*	-	-	247	-	PVC: 277
Interior with High H2S	Building Surfaces	238	-	644	-	-
	Piping	-	-	644	-	-

* See coating, lining, and/or painting paragraphs in individual piping or equipment Specification Sections.

C. Schedule Numbering Guide

First Number - Exposure		Second Number - Substrate		Third Number - Coating Type		Final Letter	
1	Interior and Weather Protected	1	Non-Ferrous Metals	1	Alkyd	S	Sewage
2	Exterior Weather Exposure	2	Wood	2	Asphaltic	W	Potable Water
3	Submerged in Potable Water but Protected from Sunlight	3	Concrete, Concrete Block, Masonry	4	Epoxy	F	Floors
4	Submerged in Potable Water and Exposed to Sunlight	4	Ferrous Metals	5	Vinyl	C	Severe Chemical Exposure
5	Submerged in Wastewater	5	Galvanized Ferrous Metals	6	Coal Tar	H	Headspace with High H ₂ S
6	Corrosive Areas	6	Drywall	7	Polyurethane		
		7	PVC Pipe	8	Acrylic		
		8	Fiberglass Reinforced Plastic	9	Zinc		
		9	Other	0	Latex		

D. Material Schedules

System: 114		Surface Preparation: SSPC SP-1	
Type: Polyamide Epoxy			
Use: Interior Non-ferrous Metal			
Coat	Minimum Dry Film Thickness (Mils)	Tnemec	Sherwin Williams
1st	3.0 – 5.0	Series 66-1211 Epoxoline Primer	Macropoxy 646 FC Epoxy
2nd	4.0 – 6.0	Series N69-Color Hi-Build Epoxoline II	Macropoxy 646 FC Epoxy
3rd	4.0 – 6.0	Series N69-Color Hi-Build Epoxoline II	Macropoxy 646 FC Epoxy
System	12.0		

System: 160		Surface Preparation: Clean and Dry	
Type: Acrylic Latex			
Use: Interior Drywall			
Coat	Minimum Dry Film Thickness (Mils)	Tnemec	Sherwin Williams
1st	As recommended by Manufacturer	Series 51 PVA Sealer	Block Filler B42KW00046 Heavy Duty Acrylic Block Filler
2nd	2.0 – 3.0	Series 1026 Enduratone	DTM B66 Series
3rd	2.0-3.0	Series 1026 Enduratone	DTM B66 Series
System	4.0-6.0		

System: 217		Surface Preparation: SSPC SP6	
Type: Epoxy-Polyurethane			
Use: Exterior Non-ferrous Metal			
Coat	Minimum Dry Film Thickness (Mils)	Tnemec	Sherwin Williams
1st	2.5-3.0	Series 66-1211 Epoxoline Primer	Macropoxy 646 Epoxy
2nd	4.0-5.0	Series N69-Color Hi-Build Epoxoline II	Macropoxy 646 Epoxy
3rd	2.5-3.0	Series 1074-Color Endura Shield II	Acrolon 218
System	9.0-11.0		

System: 238		Surface Preparation: SSPC SP WJ-4	
Type: Acrylic		Note: Concrete shall be at least 28 days old before any of these coatings are applied.	
Use: Concrete, Precast Concrete, and Masonry			
Coat	Minimum Dry Film Thickness (Mils)	Tnemec	Sherwin Williams
1st	2.0 – 3.0	Series 1026 Enduratone	CementPlex 875
2nd	2.0 – 3.0	Series 1026 Enduratone	DTM B66 Series
System	4.0- 6.0		

System: 247		Surface Preparation: SSPC-SP WJ-4	
Type: Hydrophobic Acrylic Polymer			
Use: Exterior Ferrous Metal (steel, Joists, Decking)			
Coat	Minimum Dry Film Thickness (Mils)	Tnemec	Sherwin Williams
1st	3.0	Series 135 Chembuild (Spot Prime as needed)	Zinc-Clad IV or Zinc-Clad III (Spot Prime as needed)
2nd	2.0 – 3.0	Series 30 Spra-Saf-EN	Macropoxy 646 Epoxy
3rd	2.0 - 3.0	Series 30 Spra-SAF-EN	Acrolon 218
System	4.0 – 6.0		

System: 644		Surface Preparation: SSPC-SP WJ-4	
Type: Aliphatic Polyester Polyurethane			
Use: Corrosive Environment Ferrous Metal (Building Interior)			
Coat	Minimum Dry Film Thickness (Mils)	Tnemec	Sherwin Williams
1st	3.0	Series 135 Chembuild (Spot Prime as needed)	Macropoxy 646 FC Epoxy (Spot Prime as needed)
2nd	3.0	Series 135 Chembuild	Macropoxy 646 FC Epoxy
3rd	2.0 – 3.0	Series 290 CRU	Polyion HP Polyurethane
System	5.0 – 6.0		

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.

1.2 Action Submittals

- A. Product Data: For each type of product.

1.3 Informational Submittals

- A. Field quality-control reports.

Part 2 Products

2.1 Sleeves

- A. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

2.2 Sleeve-Seal Systems

A. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig (137 kPa) minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Composite plastic.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.

2.3 Grout

- A. Description: Non-shrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 Silicone Sealants

- A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.

Part 3 Execution

3.1 Sleeve Installation

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - 2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

3.2 Sleeve-Seal-System Installation

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 Field Quality Control

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 Sleeve and Sleeve-Seal Schedule

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves.
 - 2. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): PVC pipe sleeves.
 - 3. Interior Partitions:
 - a. Piping Smaller Than NPS 6 (DN 150): PVC pipe sleeves.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. CPVC ball valves.

1.2 Action Submittals

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

Part 2 Products

2.1 General Requirements for Valves

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
 - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- G. Valves in Insulated Piping:
 - 1. Include 2-inch (50-mm) stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 CPVC Ball Valves

A. CPVC Union Ball Valves:

1. Description:

- a. Standard: MSS SP-122.
- b. Pressure Rating and Temperature: 150 psig at 73 deg F.
- c. Body Material: CPVC.
- d. Body Design: Union type.
- e. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded.
- f. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, threaded or flanged.
- g. Ball: CPVC; full port.
- h. Seals: PTFE or EPDM-rubber O-rings.
- i. Handle: Tee shaped.

B. CPVC Non-Union Ball Valves:

1. Description:

- a. Standard: MSS SP-122.
- b. Pressure Rating and Temperature: 150 psig at 73 deg F (23 deg C).
- c. Body Material: CPVC.
- d. Body Design: Non-union type.
- e. End Connections: Socket or threaded.
- f. Ball: CPVC; full or reduced port.
- g. Seals: PTFE or EPDM-rubber O-rings.
- h. Handle: Tee shaped.

Part 3 Execution

3.1 Valve Installation

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

3.2 General Requirements for Valve Applications

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

3.3 Domestic Hot- And Cold-Water Valve Schedule

- A. Pipe NPS 2-1/2 and Smaller:
 - 1. CPVC, Union-ball or Non-union ball valve.

END OF SECTION

Hangers and Supports for Plumbing Piping and Equipment

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Fastener systems.
 - 3. Pipe-positioning systems.
 - 4. Equipment supports.

1.2 Action Submittals

- A. Product Data: For each type of product.

Part 2 Products

2.1 Performance Requirements

- A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

2.2 Metal Pipe Hangers and Supports

- A. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 Fastener Systems

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- 1. Indoor Applications: stainless steel.

2.4 Pipe-Positioning Systems

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.5 Materials

- A. Aluminum: ASTM B221 (ASTM B221M).
- B. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- C. Stainless Steel: ASTM A240/A240M.
- D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and non-gaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

Part 3 Execution

3.1 Application

- A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

3.2 Hanger and Support Installation

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated

tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- C. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- I. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 Equipment Supports

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 Metal Fabrications

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

3.5 Adjusting

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.6 Painting

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 Hanger and Support Schedule

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C) pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction occurs.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction occurs.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches (150 mm) for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb (680 kg).
 - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.

- b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- M. Use powder-actuated fasteners instead of building attachments where required in concrete construction.
- N. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.2 Action Submittals

- A. Product Data: For each type of product indicated.

Part 2 Products

2.1 Equipment Labels

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Yellow.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 Warning Signs and Labels

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Yellow.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 Pipe Labels

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.

Part 3 Execution

3.1 Equipment Label Installation

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.2 Pipe Label Installation

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. CPVC piping.
 - 2. Piping joining materials.
 - 3. Transition fittings.
 - 4. Dielectric fittings.

1.2 Action Submittals

- A. Product Data: For transition fittings and dielectric fittings.

1.3 Warranty

- A. CPVC Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.
 - 1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
 - 2. Warranty is to be in effect only upon submission by the Contractor to the manufacturer of valid pressure/leak documentation indicating that the system was tested and passed the manufacturer's pressure/leak test.

Part 2 Products

2.1 Piping Materials

- A. Comply with requirements in section 2.2 below for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

2.2 CPVC Piping

- A. CPVC Pipe: ASTM F441/F441M, with wall thickness as indicated in "Piping Applications" Article.

1. CPVC Socket Fittings: ASTM F438 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F437, Schedule 80.
- B. CPVC Piping System: ASTM D2846/D2846M, SDR 11, pipe and socket fittings.
- C. CPVC Tubing System: ASTM D2846/D2846M, SDR 11, tube and socket fittings.

2.3 Piping Joining Materials

- A. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.
- B. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 Transition Fittings

- A. General Requirements:
 1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:
 1. Description:
 - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- D. Plastic-to-Metal Transition Unions:
 1. Description:
 - a. CPVC four-part union.
 - b. Brass threaded end.
 - c. Solvent-cement-joint or threaded plastic end.

- d. Rubber O-ring.
- e. Union nut.

2.5 Dielectric Fittings

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating non-conductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 - 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Standard: ASSE 1079.
 - 2. Factory-fabricated, bolted, companion-flange assembly.
 - 3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Non-conducting materials for field assembly of companion flanges.
 - 2. Pressure Rating: 150 psig (1035 kPa).
 - 3. Gasket: Neoprene or phenolic.
 - 4. Bolt Sleeves: Phenolic or polyethylene.
 - 5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Standard: IAPMO PS 66.
 - 2. Electroplated steel nipple complying with ASTM F1545.
 - 3. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).

4. End Connections: Male threaded or grooved.
5. Lining: Inert and non-corrosive, propylene.

Part 3 Execution

3.1 Piping Applications

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
 1. CPVC, Schedule 80; threaded or socket fittings; and solvent-cemented joints.
 2. CPVC Tubing System: CPVC tube; CPVC threaded or socket fittings; and solvent-cemented joints.
- D. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be the following:
 1. CPVC, Schedule 80; threaded or socket fittings; and solvent-cemented joints.

3.2 Installation of Piping

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 - Domestic Water Piping Specialties.
- C. Install domestic water piping level without pitch and plumb.
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- F. Install piping to permit valve servicing.
- G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.
- K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.

3.3 Joint Construction

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
- E. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 Installation of Transition Fittings

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.5 Installation of Dielectric Fittings

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.6 Installation of Hangers and Supports

- A. Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
- B. Install vinyl-coated hangers for CPVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches (300 mm) of each fitting.
- D. Support vertical runs of CPVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 Connections

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.8 Identification

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.9 Adjusting

- A. Perform the following adjustments before operation:
 1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 Field Quality Control

- A. Perform the following tests and inspections:
 1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.11 Cleaning

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Backflow preventers.
2. Water pressure-reducing valves.
3. Strainers for domestic water piping.
4. Washdown hydrants.

B. Related Requirements:

1. Section 22 45 00 - Emergency Plumbing Fixtures for water tempering equipment.

1.2 Action Submittals

- A. Product Data: For each type of product.

1.3 Closeout Submittals

- A. Operation and maintenance data.

Part 2 Products

2.1 General Requirements for Piping Specialties

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 Performance Requirements

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.3 Backflow Preventers

- A. Reduced-Pressure-Principle Backflow Preventers: Zurn Wilkins 375A or equivalent.
 - 1. Standard: ASSE 1013.
 - 2. Operation: Continuous-pressure applications.
 - 3. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
 - 4. Size: Line size, refer to drawings.
 - 5. Body: Bronze with corrosion resistant coating for NPS 2 (DN 50) and smaller; Ductile Iron with corrosion resistant coating for NPS 2-1/2 (DN 65) and larger.
 - 6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - 7. Configuration: Refer to drawings for flow orientation.
 - 8. Accessories:
 - a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- B. Double-Check, Backflow-Prevention Assemblies:
 - 1. Standard: ASSE 1015.
 - 2. Operation: Continuous-pressure applications unless otherwise indicated.
 - 3. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
 - 4. Size: Line size, refer to drawings.
 - 5. Body: Bronze with corrosion resistant coating for NPS 2 (DN 50) and smaller; for NPS 2-1/2 (DN 65) and larger.
 - 6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - 7. Configuration: Refer to drawings for flow orientation.
 - 8. Accessories:

- a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
- b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.4 Water Pressure-Reducing Valves

- A. Water Regulators: Zurn PW209 or equivalent.
 - 1. Standard: ASSE 1003.
 - 2. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
 - 3. Size: Line size, refer to drawings.
 - 4. Body: Bronze with corrosion resistant coating for NPS 2 (DN 50) and smaller; Ductile Iron with corrosion resistant coating for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
 - 5. Valves for Booster Heater Water Supply: Include integral bypass.
 - 6. End Connections: Threaded or solder for NPS 2 (DN 50) and smaller; flanged or solder for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

2.5 Strainers for Domestic Water Piping

- A. Y-Pattern Strainers:
 - 1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - 2. Body: Bronze with corrosion resistant coating for NPS 2 (DN 50) and smaller; cast iron with corrosion resistant coating for NPS 2-1/2 (DN 65) and larger.
 - 3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - 4. Screen: Stainless steel with round perforations unless otherwise indicated.
 - 5. Perforation Size:
 - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
 - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
 - c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).
 - 6. Drain: Pipe plug.

2.6 Washdown Hydrants

A. Moderate-Climate Wall Hydrants:

1. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig (860 kPa).
3. Operation: Loose key.
4. Inlet: NPS 1 (DN 20 or DN 25).
5. Outlet, Exposed:
 - a. With integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7.
6. Nozzle and Wall-Plate Finish: Polished nickel bronze.

Part 3 Execution

3.1 Installation of Piping Specialties

- A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Y-Pattern Strainers: For water, install on supply side of each water pressure-reducing valve.
- C. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

3.2 Piping Connections

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 Electrical Connections

- A. Connect wiring in accordance with Division 26 specifications.
- B. Ground equipment in accordance with Division 26 specifications.
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 Control Connections

- A. Connect control wiring in accordance with Division 26 specifications.

3.5 Identification

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Backflow preventers.
 - 2. Water pressure-reducing valves.
 - 3. Washdown hydrants.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.6 Adjusting

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Adjust each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 Field Quality Control

- A. Perform the following tests and inspections.
 - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. Thermostat-control, electric, tankless, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.2 Action Submittals

- A. Product Data: For each type of product.

1.3 Informational Submittals

- A. Product Certificates: For each type of tankless, electric, domestic-water heater.
- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample warranty.

1.4 Closeout Submittals

- A. Operation and maintenance data.

1.5 Warranty

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Periods: From date of Substantial Completion.
 - a. Electric, Tankless, Domestic-Water Heaters: Five year(s).

Part 2 Products

2.1 Performance Requirements

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 Electric, Tankless, Domestic-Water Heaters

- A. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:
 - 1. Standard: UL 499 for electric, tankless, (domestic-water-heater) heating appliance.
 - 2. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig (1035 kPa).
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Thermostat.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 - 3. Support: Bracket for wall mounting.
 - 4. Capacity and Characteristics: Refer to drawings

2.3 Domestic-Water Heater Accessories

- A. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic water heater and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.
- B. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- (172.5-kPa-) maximum outlet pressure unless otherwise indicated.
- C. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

- D. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.
- E. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- F. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- G. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 Source Quality Control

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

Part 3 Execution

3.1 Domestic-Water Heater Installation

- A. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 36 inches (457 mm) above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for

shutoff valves specified in Section 22 05 23.12 - Ball Valves for Plumbing Piping.

- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 - Domestic Water Piping Specialties.
- F. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.
- G. Identify system components. Comply with requirements for identification specified in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.2 Piping Connections

- A. Comply with requirements for piping specified in Section 22 11 16 - Domestic Water Piping. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 Field Quality Control

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform tests and inspections.
- D. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.4 Demonstration

- A. Train Owner's maintenance personnel to adjust, operate, and maintain tankless, electric, domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. Eye/face wash equipment.

1.2 Action Submittals

- A. Product Data: For each type of product.

1.3 Informational Submittals

- A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- B. Field quality-control test reports.

1.4 Closeout Submittals

- A. Operation and maintenance data.

Part 2 Products

2.1 Performance Requirements

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ISEA Standard: Comply with ISEA Z358.1.
- C. NSF Standard: Comply with NSF 61 and NSF 372, for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC A117.1, for plumbing fixtures for people with disabilities.

2.2 Eye/Face Wash Equipment

- A. Standard, Freestanding, Plumbed Eye/Face Wash Units:
 - 1. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
 - 2. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

3. Control-Valve Actuator: Paddle.
4. Spray-Head Assembly: Two or four receptor-mounted spray heads.
5. Receptor: Plastic bowl.
6. Drain Piping:
 - a. Size: NPS 1-1/4 (DN 32) minimum.
 - b. Finish: Chrome-plated brass.
 - c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
7. Drain Piping: Include galvanized-steel indirect connection to drainage system.
8. Mounting: Pedestal.

2.3 Source Quality Control

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

Part 3 Execution

3.1 Installation of Emergency Plumbing Fixture

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of the equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation.
 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 11 16 - Domestic Water Piping.

3.2 Connections

- A. Connect Warm-water-supply piping to electric water heater equipment. Connect output from water heater to emergency plumbing fixtures. Comply with requirements for water piping specified in Section 22 11 16 - Domestic Water Piping.
- B. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.3 Identification

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.4 Field Quality Control

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 Adjusting

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

Common Motor Requirements for HVAC Equipment

Part 1 General

1.1 Summary

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 Coordination

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

Part 2 Products

2.1 General Motor Requirements

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 Motor Characteristics

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 Polyphase Motors

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 Additional Requirements for Polyphase Motors

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

2.5 Single-Phase Motors

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.

- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.

1.2 Action Submittals

- A. Product Data: For each type of product.

Part 2 Products

2.1 Sleeves

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anti-corrosion coated, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Pipe Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

2.2 Sleeve-Seal Systems

A. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig (137-kPa) minimum).
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Composite plastic.

5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.

2.3 Grout

- A. Description: Non-shrink, recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 Silicone Sealants

- A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

Part 3 Execution

3.1 Sleeve Installation

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 2. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

3.2 Sleeve-Seal-System Installation

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 Field Quality Control

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 Sleeve and Sleeve-Seal Schedule

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Sleeve-seal fittings.
 - 2. Interior Partitions:
 - a. Piping Smaller Than NPS 6 (DN 150): PVC-pipe sleeves.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section includes application of coating systems on internal HVAC components and external equipment surfaces, including the following systems:
 - 1. Bake-cured corrosion-resistant coating systems.
 - 2. Air-dried corrosion-resistant coating systems.

1.2 Definitions

- A. Salt Water Acetic Acid Test (SWAAT): A salt fog-spray test of corrosion resistance performed in accordance with ASTM G85, Annex 3.

1.3 Action Submittals

- A. Product Data: For each type of product.

1.4 Informational Submittals

- A. Source Quality-Control Reports:
 - 1. Certification of coating material testing.

1.5 Conditions for Coating Application

- A. Comply with manufacturer's recommendations regarding required temperature and humidity ranges during coating application.

Part 2 Products

2.1 Corrosion-Resistant Coating Systems, General

- A. Material Compatibility:
 - 1. Provide materials for application within each coating system that are compatible with one another and with metal substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coating material in coating system, submit compatibility certification from manufacturer of each coating product that products are compatible with

substrate base material and with substrate-coating products applied as earlier coats.

3. Products shall be of same manufacturer for each coat in a coating system.

2.2 Bake-Cured Corrosion-Resistant Coating Systems

A. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: 1500 hours.
2. Cross-Hatch Adhesion: ASTM D3359: 5B.
3. SWAAT: ASTM G85: 1000 hours.
4. Cyclic Weathering: ISO 12944-9, 4200 hours.
5. Mandrel Flexibility: ASTM D522/D522M: 1/4 inch (6 mm) without cracking or delamination of film after full cure.
6. Adhesion - Elcometer: ASTM D4541: 1100 psi (7.6 MPa).
7. Impact: ASTM D2794.
 - a. Direct Hit: 70 lb.-in. (7.9 N-m).
 - b. Reverse Hit: 20 lb.-in. (2.2 N-m).
8. pH Range: 14-Day Liquid Spot Test: 2.4 to 12.6.
9. Dry Heat Resistance: ASTM D2485: 320 deg F (160 deg C) maximum.
10. Dry Film Thickness: 0.5 to 1.2 mils (0.013 to 0.030 mm).
11. Heat-Transfer Reduction: 1 percent maximum.
12. Hardness: ASTM D3363 Pencil Test: 2B-HB.

B. Bake-Cured, Immersion-Applied Phenolic Epoxy System.

2.3 Source Quality Control

- ### A. Certification of Coating Material Testing: Submit manufacturer's test report of corrosion-resistance performance testing, as performed by a nationally recognized testing laboratory.

Part 3 Execution

3.1 Preparation

- A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.
 - 1. Thinning: Thin coating material with manufacturer's recommended thinning products when recommended or permitted by coating system manufacturer.
- B. Comply with coating system manufacturer's recommendations to clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

3.2 Application

- A. Verify with coating manufacturer whether coatings required must be applied and cured in factory-certified application shop.
- B. Apply coating systems with equipment designed to deposit coating of specified uniform thickness over HVAC components, in complex, three-dimensional geometries.
 - 1. Apply coatings with manufacturer-recommended tools and techniques suited for specified coating system and each coated HVAC component.
 - 2. Do not apply coatings over labels or equipment name, identification, performance rating, or nomenclature plates.
- C. Perform inspection and coating system manufacturer's recommended tests to verify coating integrity and thickness. Where coating was damaged by testing, repair damage in accordance with coating system manufacturer's written recommendations.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.

1.2 Action Submittals

- A. Product Data: For each type of product.

Part 2 Products

2.1 Equipment Labels

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Yellow.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and

schedules), and the Specification Section number and title where equipment is specified.

- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 Warning Signs and Labels

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Yellow.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

Part 3 Execution

3.1 Preparation

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 Equipment Label Installation

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems.
2. Testing, adjusting, and balancing of equipment.
3. Testing, adjusting, and balancing of existing HVAC systems and equipment.
4. HVAC-control system verification.

1.2 Definitions

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
- G. UFAD: Underfloor air distribution.

1.3 Informational Submittals

- A. Certified TAB reports.
- B. Instrument calibration reports, to include the following:
1. Instrument type and make.
 2. Serial number.
 3. Application.
 4. Dates of use.
 5. Dates of calibration.

1.4 Quality Assurance

- A. TAB Specialists Qualifications, Certified by AABC:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.5 Field Conditions

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

Part 2 Products

(NOT USED)

Part 3 Execution

3.1 Examination

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

- E. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- F. Examine test reports specified in individual system and equipment Sections.
- G. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- H. Examine operating safety interlocks and controls on HVAC equipment.
- I. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 Preparation

- A. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Clean filters are installed.
 - b. Fans are operating, free of vibration, and rotating in correct direction.
 - c. Automatic temperature-control systems are operational.
 - d. Ceilings are installed.
 - e. Windows and doors are installed.
 - f. Suitable access to balancing devices and equipment is provided.

3.3 General Procedures for Testing and Balancing

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 - Air Duct Accessories.
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 Testing, Adjusting, and Balancing of HVAC Equipment

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
1. Motors.
 2. Fans and ventilators.
 3. Packaged air conditioners.
 4. Heat pumps.

3.5 General Procedures for Balancing Air Systems

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.
- C. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- D. Verify that motor starters are equipped with properly sized thermal protection.
- E. Check dampers for proper position to achieve desired airflow path.
- F. Check for airflow blockages.
- G. Check condensate drains for proper connections and functioning.
- H. Check for proper sealing of air-handling-unit components.

3.6 Procedures for Constant-Volume Air Systems

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - b. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.

3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that total airflow is within design.
 2. Re-measure all final fan operating data, speed, volts, amps, and static profile.
 3. Mark all final settings.
 4. Measure and record all operating data.
 5. Record final fan-performance data.

3.7 Procedures for Motors

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.

3.8 HVAC Controls Verification

- A. In conjunction with system balancing, perform the following:
1. Verify HVAC control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.
 4. Verify that controller set points are as indicated.

5. Verify the operation of lockout or interlock systems.
 6. Verify the operation of valve and damper actuators.
 7. Verify that controlled devices are properly installed and connected to correct controller.
 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.9 Procedures for Testing, Adjusting, and Balancing Existing Systems

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure the airflows at each air terminal in the laboratory room and restroom.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Balance the packaged air handling unit fan speed at the unit to match preconstruction airflows of air terminals.

3.10 Tolerances

- A. Set HVAC system's airflow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm (47 L/s), within 10 cfm (4.7 L/s).
 - 2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm (47 L/s), within 10 cfm (4.7 L/s).
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.11 Final Report

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Manufacturers' test data.
 - 2. Field test reports prepared by system and equipment installers.
 - 3. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Contractor's name and address.
 - 6. Report date.

7. Signature of TAB supervisor who certifies the report.
 8. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 9. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 10. Nomenclature sheets for each item of equipment.
 11. Data for terminal units, including manufacturer's name, type, size, and fittings.
 12. Notes to explain why certain final data in the body of reports vary from indicated values.
 13. Test conditions for fans performance forms, including the following:
 - a. Conditions of filters.
 - b. Cooling coil, wet- and dry-bulb conditions.
 - c. Heating coil, dry-bulb conditions.
 - d. Fan drive settings, including settings and percentage of maximum pitch diameter.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.

- d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches (mm), and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and speed.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan speed.
 - d. Inlet and discharge static pressure in inches wg (Pa).
 - e. For each filter bank, filter static-pressure differential in inches wg (Pa).
 - f. List for each internal component with pressure-drop, static-pressure differential in inches wg (Pa).
 - g. Outdoor airflow in cfm (L/s).
 - h. Return airflow in cfm (L/s).

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches (mm), and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and speed.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan speed.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).

G. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.12 Additional Tests

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section includes insulating the following duct services:

1. Indoor, concealed supply air.
2. Indoor, exposed supply air.

1.2 Action Submittals

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 3. Detail application of field-applied jackets.
 4. Detail application at linkages of control devices.

1.3 Informational Submittals

- A. Field quality-control reports.

1.4 Quality Assurance

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

Part 2 Products

2.1 Insulation Materials

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 Adhesives

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 Mastics and Coatings

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm (0.66 metric perms) at manufacturer's recommended dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
 3. Color: White.

2.4 Sealants

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.5 Factory-Applied Jackets

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
 - 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 Field-Applied Fabric-Reinforcing Mesh

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.

2.7 Field-Applied Jackets

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.8 Tapes

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches (75 mm).
 - 2. Thickness: 11.5 mils (0.29 mm).
 - 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - 4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Width: 3 inches (75 mm).
 2. Thickness: 6.5 mils (0.16 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches (50 mm).
 2. Thickness: 6 mils (0.15 mm).
 3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches (50 mm).
 2. Thickness: 3.7 mils (0.093 mm).
 3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.9 Securements

- A. Aluminum Bands: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

Part 3 Execution

3.1 Preparation

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 General Installation Requirements

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
 - a. For below ambient services, apply vapor barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 Penetrations

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (that are not fire rated): Install insulation continuously through walls and partitions.

3.4 Installation of Mineral-Fiber Insulation

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
 5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm)

- maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
- c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.5 Field-Applied Jacket Installation

- A. Where FSK jackets are indicated, install as follows:
- 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.6 Field Quality Control

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 Duct Insulation Schedule, General

- A. Plenums and Ducts Requiring Insulation:
1. Indoor supply and return where called out on drawings.
- B. Items Not Insulated:
1. Fibrous-glass ducts.
 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 3. Factory-insulated flexible ducts.
 4. Factory-insulated plenums and casings.
 5. Flexible connectors.
 6. Vibration-control devices.
 7. Factory-insulated access panels and doors.

3.8 Indoor Duct and Plenum Insulation Schedule

- A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket with FSK jacket, 2 inches (50 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
- B. Exposed, Supply-Air Duct and Plenum Insulation: Mineral-fiber board with FSK jacket, 2 inches (50 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
- C. Exposed in unconditioned space, Return-Air Duct and Plenum Insulation: Mineral-fiber board with FSK jacket, 2 inches (50 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

END OF SECTION

Part 1 General

1.1 Related Documents

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 Summary

- A. Section Includes:

- 1. Single-wall rectangular ducts and fittings.
- 2. Single-wall round ducts and fittings.
- 3. Sheet metal materials.
- 4. Sealants and gaskets.
- 5. Hangers and supports.

- B. Related Sections:

- 1. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for testing, adjusting, and balancing requirements for metal ducts.
- 2. Section 23 33 00 - Air Duct Accessories for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 Action Submittals

- A. Product Data: For each type of the following products:

- 1. Liners and adhesives.
- 2. Sealants and gaskets.
- 3. Seismic-restraint devices.

1.4 Informational Submittals

- A. Welding certificates.
- B. Field quality-control reports.

1.5 Quality Assurance

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

Part 2 Products

2.1 Performance Requirements

- A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
- B. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- E. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 Single-Wall Rectangular Ducts and Fittings

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches (914 mm), select joint types in accordance with Figure 2-1.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
 - D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 Single-Wall Round Ducts and Fittings

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 Sheet Metal Materials

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall

be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G60 (Z180).
- C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
- D. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- E. Tie Rods: Galvanized steel, 1/4-inch- (6-mm-) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch- (10-mm-) minimum diameter for lengths longer than 36 inches (900 mm).

2.5 Sealant and Gaskets

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 3 inches (76 mm).
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
 10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
 11. Service: Indoor or outdoor.
 12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 Hangers and Supports

- A. Hanger Rods for Non-corrosive Environments: Galvanized-steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

Part 3 Execution

3.1 Duct Installation

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and

arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- J. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- K. Elbows: Use long-radius elbows wherever they fit.
 - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
 - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.
- L. Branch Connections: Use lateral or conical branch connections.

3.2 Duct Sealing

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
 - 3. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 Hanger and Support Installation

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1220 mm) of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet (5 m).
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 Connections

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 - Air Duct Accessories.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 Field Quality Control

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Supply Ducts with a Pressure Class of 2- (500) Inch wg (Pa) or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - b. Return Ducts with a Pressure Class of 2- (500) Inch wg (Pa) or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
 - 5. Test for leaks before applying external insulation.
 - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 7. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 Duct Cleaning

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use duct cleaning methodology as indicated in NADCA ACR.
- C. Use service openings for entry and inspection.
 1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 - Air Duct Accessories for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- D. Particulate Collection and Odor Control:
 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- E. Clean the following components by removing surface contaminants and deposits:
 1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.7 Startup

- A. Air Balance: Comply with requirements in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

3.8 Duct Schedule

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 - 1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
- B. Supply Ducts:
 - 1. Ducts Connected to Filtration Units:
 - a. Pressure Class: Positive 1- (250)inch wg (Pa)
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 2
 - d. SMACNA Leakage Class for Round: 2
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive 2- (500)inch wg (Pa)
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 2
 - d. SMACNA Leakage Class for Round: 2
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2- (500)inch wg (Pa)
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 2
 - d. SMACNA Leakage Class for Round: 2
- C. Return Ducts:
 - 1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2- (500)inch wg (Pa)
 - b. Minimum SMACNA Seal Class: A

- c. SMACNA Leakage Class for Rectangular: 2
 - d. SMACNA Leakage Class for Round: 2
 - 2. Ducts Connected to Equipment Not Listed above:
 - a. Pressure Class: Positive or negative 2- (500)inch wg (Pa)
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 2
 - d. SMACNA Leakage Class for Round: 2
- D. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
- E. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm (5 m/s) or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct

Construction Standards - Metal and Flexible," Figure 4-3, "Vaness and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 (305) Inches (mm) and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 (356) Inches (mm) and Larger in Diameter: Standing seam.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Conical spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Duct access panel assemblies.
8. Flexible connectors.
9. Duct accessory hardware.

1.2 Action Submittals

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Source quality-control reports.

1.3 Closeout Submittals

A. Operation and maintenance data.

Part 2 Products

2.1 Performance Requirements

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods

unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 Manual Volume Dampers

A. Standard, Steel, Manual Volume Dampers:

1. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. (203 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
2. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
3. Frames:
 - a. Hat-shaped, 16-gauge- (1.6-mm-) thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel; 16 gauge (1.6 mm) thick.
5. Blade Axles: Galvanized steel.
6. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
7. Tie Bars and Brackets: Galvanized steel.
8. Locking device to hold damper blades in a fixed position without vibration.

B. Jackshaft:

1. Size: 0.5-inch (13-mm) diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 Control Dampers

A. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

B. Performance:

1. AMCA Certification: Test and rate in accordance with AMCA 511.
2. Leakage:
 - a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
 - b. Class I: Leakage shall not exceed 4 cfm/sq. ft. (20 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
 - c. Class II: Leakage shall not exceed 10 cfm/sq. ft. (51 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
 - d. Class III: Leakage shall not exceed 40 cfm/sq. ft. (203 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.

3. Pressure Drop: 0.05 inch wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm (15 m/s).
5. Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C).
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

C. Construction:

1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:
 - a. Hat, U, or angle shaped.
 - b. 0.08-inch- (2.0-mm-) thick extruded aluminum.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
 - a. Multiple blades with maximum blade width of 6 inches (150 mm).
 - b. Parallel-blade design.
 - c. Galvanized steel.
 - d. 16-gauge- (1.6-mm-) thick single skin or 14-gauge- (1.9-mm-) thick air foil dual skin.
5. Blade Edging Seals:
 - a. Replaceable closed-cell neoprene.
 - b. Inflatable seal blade edging, or replaceable rubber seals.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch (13-mm) diameter; galvanized steel.

8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.
- D. Damper Actuator - Electric:
 1. Electric - 24 V ac.
 2. UL 873, plenum rated.
 3. Two position with fail-safe spring return.
 - a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
 - b. Minimum 90-degree drive rotation.
 4. Clockwise or counterclockwise drive rotation as required for application.
 5. Environmental Operating Range:
 - a. Temperature: Minus 40 to plus 130 deg F (Minus 40 to plus 55 deg C).
 - b. Humidity: 5 to 95 percent relative humidity noncondensing.
 6. Environmental enclosure: NEMA 2.
 7. Actuator to be factory mounted and provided with a single-point wiring connection.

2.4 Flange Connectors

- A. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.
- B. Material: Galvanized steel.
- C. Gauge and Shape: Match connecting ductwork.

2.5 Turning Vanes

- A. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vaness and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- D. Vane Construction:
 1. Single wall.
 2. Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

2.6 Duct-Mounted Access Doors

- A. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. 24-gauge- (0.70-mm-) thick galvanized steel or 0.032-inch (0.81-mm) thick aluminum or 24-gauge- (0.70-mm-) thick stainless steel door panel.
 - d. Vision panel.
 - e. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
 - f. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - a. 24-gauge- (0.70-mm-) thick galvanized steel or 0.032-inch- (0.81-mm-) thick aluminum frame.

3. Number of Hinges and Locks:

- a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
- b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
- c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
- d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

2.7 Duct Access Panel Assemblies

- A. Access panels used in cooking applications:
 - 1. Labeled compliant to NFPA 96 for grease duct access doors.
 - 2. Labeled in accordance with UL 1978 by an NRTL.
- B. Panel and Frame: Minimum thickness 16-gauge (1.6-mm) carbon steel.
- C. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- D. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).
- E. Minimum Pressure Rating: 10 inches wg (2500 Pa) positive or negative.

2.8 Flexible Connectors

- A. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Materials: Flame-retardant or noncombustible fabrics.
- D. Coatings and Adhesives: Comply with UL 181, Class 1.
- E. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

- F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
 - 2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).
- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.9 Duct Accessory Hardware

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.10 Materials

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G60 (Z180).
 - 2. Exposed-Surface Finish: Mill phosphatized.

- B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304.
- C. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M), Alloy 3003, Temper H14.
- D. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

Part 3 Execution

3.1 Installation

- A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. At each change in direction and at maximum 50-ft. (15-m) spacing.
 - 7. Upstream from turning vanes.
 - 8. Control devices requiring inspection.
 - 9. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
 - 2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
 - 3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
 - 4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
 - 5. Body Access: 25 by 14 inches (635 by 355 mm).
 - 6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).
- K. Label access doors according to Section 23 05 53 - Identification for HVAC Piping and Equipment to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5 inches wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Install duct test holes where required for testing and balancing purposes.

- O. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

3.2 Field Quality Control

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that size and location of access doors are adequate to perform required operation.
 - 3. Inspect turning vanes for proper and secure installation and verify that vanes do not move or rattle.
 - 4. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

Part 1 General

1.1 Summary

A. Section Includes:

1. Rectangular and square ceiling diffusers.

B. Related Requirements:

1. Section 23 33 00 - Air Duct Accessories for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 23 37 13.23 - Air Registers and Grilles for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.2 Action Submittals

- A. Product Data: For each type of product.

Part 2 Products

2.1 Rectangular and Square Ceiling Diffusers

- A. Refer to Air Terminal Schedule on plans.

Part 3 Execution

3.1 Installation

- A. Install diffusers level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 Adjusting

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

Part 1 General

1.1 Summary

- A. Section Includes:
 - 1. Fixed face grilles.
- B. Related Requirements:
 - 1. Section 23 33 00 - Air Duct Accessories for volume-control dampers not integral to registers and grilles.
 - 2. Section 23 37 13.13 - Air Diffusers for various types of air diffusers.

1.2 Action Submittals

- A. Product Data: For each type of product.

Part 2 Products

2.1 Grilles

- A. Refer to Air Terminal Schedule on plans.

Part 3 Execution

3.1 Installation

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 Adjusting

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

Packaged, Small-Capacity, Rooftop Air-Conditioning Units

Part 1 General

1.1 Summary

- A. Section includes packaged, small-capacity, rooftop air-conditioning units (RTUs) with the following components:
 - 1. Casings.
 - 2. Fans, drives, and motors.
 - 3. Coils.
 - 4. Refrigerant circuit components.
 - 5. Air filtration.
 - 6. Dampers.
 - 7. Electrical power connections.
 - 8. Controls.
 - 9. Roof curbs.
 - 10. Accessories.

1.2 Action Submittals

- A. Product Data: For each type of RTU.

1.3 Informational Submittals

- A. Sample Warranty: For manufacturer's warranty.
- B. Source quality-control reports.
- C. System startup reports.
- D. Field quality-control reports.

1.4 Closeout Submittals

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.5 Warranty

- A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 1 year(s) from date of Substantial Completion.
 - 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

Part 2 Products

2.1 Performance Requirements

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. UL Compliance: Comply with UL 1995.

2.2 Capacities and Characteristics

- A. Refer to Schedule on plans.

2.3 Manufacturers

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corporation; a unit of United Technologies Corp.
 - 2. Daikin Applied.
 - 3. Lennox Industries, Inc.; Lennox International.
 - 4. Trane.

2.4 Unit Casings

- A. General Fabrication Requirements for Casings: Formed and reinforced single-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- C. Static-Pressure Classifications:
 - 1. For Unit Sections Upstream of Fans: Minus 2-inch wg (500 Pa).
 - 2. For Unit Sections Downstream and Including Fans: 2-inch wg (500 Pa).
- D. Panels and Doors:
 - 1. Panels:
 - a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 2. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 3. Locations and Applications:
 - a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panels.

- d. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - e. Mixing Section: Doors.
- E. Condensate Drain Pans:
 - 1. Location: Each type of cooling coil.
 - 2. Construction:
 - a. Single-wall, stainless steel sheet.
 - 3. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - b. Minimum Connection Size: NPS 1 (DN 25).
 - 4. Slope: Minimum 0.125-in./ft. (10-mm/mm) slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - 5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
 - 6. Width: Entire width of water producing device.
 - 7. Depth: A minimum of 2 inches (50 mm) deep.
 - 8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.

2.5 Fans, Drives, And Motors

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.

2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.
 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
 5. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch (25 mm).
 6. Shaft Lubrication Lines: Extended to a location outside the casing.
 7. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches (89 mm) wide, attached to two strips of minimum 2-3/4-inch- (70-mm-)wide by 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
- C. Drives, Direct: Factory-mounted, direct drive.
- D. Condenser-Coil Fan: propeller, mounted on shaft of permanently lubricated multispeed motors.
- E. Motors:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 3. Enclosure Type: Open, dripproof.
 4. Enclosure Materials: Cast iron.
 5. Efficiency: Premium efficient as defined in NEMA MG 1.

6. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
7. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.6 Coils

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

B. Supply-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: Maximum 12 fins per inch (mm).
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig (2070 kPa).

C. Electric-Resistance Heating Coils: Comply with UL 1995.

1. Casing Assembly: Slip-in type with galvanized-steel frame.
2. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

3. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
4. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
5. Control Panel: Unit mounted with disconnecting means and overcurrent protection.
 - a. Magnetic contactor.
 - b. Solid-state, stepless pulse controller.
 - c. Toggle switches, one per step.
 - d. Step controller.
 - e. Time-delay relay.
 - f. Pilot lights, one per step.
 - g. Airflow proving switch.

2.7 Refrigerant Circuit Components

- A. Compressor: Hermetic, two speed scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
- B. Refrigeration Specialties:
 1. Refrigerant: R-410A.
 2. Expansion valve with replaceable thermostatic element.
 3. Refrigerant filter/dryer.
 4. Manual-reset high-pressure safety switch.
 5. Automatic-reset low-pressure safety switch.
 6. Minimum off-time relay.
 7. Automatic-reset compressor motor thermal overload.
 8. Brass service valves installed in compressor suction and liquid lines.
 9. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.8 Air Filtration

- A. Panel Filters:
 - 1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
 - 4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
- B. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.

2.9 Electrical Power Connections

- A. RTU shall have a single connection of power to unit with wall-mounted disconnect switch. Switch to be provided and installed by Division 26.

2.10 Controls

- A. Unit to have Stand Alone Packaged Controls. Refer to controls sheets on drawings.

2.11 Roof Curbs

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C1071, Type I or II.
 - b. Thickness: 1 inch (25 mm).
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

- c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C916, Type I.
- B. Curb Dimensions: Height of 14 inches (355 mm). Adaptable horizontal dimensions as required for existing openings.

2.12 Accessories

- A. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature in gas burner compartment.
- B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- D. Factory- or field-installed, demand-controlled ventilation.
- E. Safeties:
 - 1. Condensate overflow switch.
 - 2. Phase-loss reversal protection.
 - 3. High- and low-pressure control.
 - 4. Electric coil airflow-proving switch.
- F. Coil guards of painted, galvanized-steel wire.
- G. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.
- H. Door switches to disable heating or reset set point when open.
- I. Oil separator.

2.13 Materials

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209 (ASTM B209M).

2.14 Source Quality Control

A. AHRI Compliance:

1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested according to AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

Part 3 Execution

3.1 Installation

- A. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- B. Roof Curb: Install on platform structure or concrete base, level and secure, according to AHRI Guideline B. Install RTUs on curbs and coordinate platform penetrations and flashing with platform construction. Secure RTUs to upper curb rail, and secure curb base to platform framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

3.2 Piping Connections

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to RTU, allow space for service and maintenance.
- C. Connect piping to unit mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4 (DN 32), ASTM B88, Type M (ASTM B88M, Type C) copper tubing. Extend to exterior. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.3 Duct Connections

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Connect supply ducts to RTUs with flexible duct connectors specified in Section 23 33 00 - Air Duct Accessories.
 - 3. Install return-air duct continuously through platform structure.

3.4 Electrical Connections

- A. Connect electrical wiring according to Division 26 specifications.
- B. Ground equipment according to Division 26 Specifications.
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch (13 mm) high.
 - 2. Locate nameplate where easily visible.

3.5 Control Connections

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Division 26 specifications.

3.6 Field Quality Control

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform tests and inspections.
- D. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. RTU will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.7 Demonstration

- A. Train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION

Part 1 General

1.1 Scope

- A. The electrical work commences with the point of electrical service where shown on the Drawings and includes furnishing all material and labor for a complete electrical installation.
- B. The requirements of Division 01 apply to all work hereunder. The General and Special Conditions are a part of this Division of the Specifications and all provisions contained therein which affect this work are as binding as though incorporated herein.

1.2 Definitions

- A. Provide: Furnish, install, and connect.
- B. Product Data: Catalog cuts and descriptive literature.
- C. Shop Drawings: Factory prepared specific to the installation.
- D. Low Voltage: 0-600 volts.
- E. High Voltage: Above 600 volts.
- F. Indicated: Shown on the Drawings.
- G. Noted: Indicated or specified elsewhere.

1.3 Material Not Furnished

- A. Unless otherwise noted, electric motors, factory-supplied process equipment control panels, and local control (PLC/SCADA) panels are furnished and installed under other Divisions.
- B. Unless otherwise noted, the following are furnished and installed under other Divisions:
 - 1. Motors.
 - 2. Motor starters integral with process or HVAC equipment.
 - 3. Electric heating and air conditioning equipment.
 - 4. Building energy management systems.

5. Electrical heat tracing.
 6. Pilot and control devices for the above equipment.
- C. All power wiring including associated terminations is provided under this Division. Control and signal wiring shown on the electrical drawings, including associated terminations is also provided under this Division. Control wiring for mechanical equipment not shown on the electrical drawings is provided under Division 23.

1.4 Local Conditions

- A. Power will be supplied by the utility company overhead distribution system. Verify and comply with all power company requirements for metering and terminations. Make necessary arrangements with the power company for temporary service requirements.
- B. Telephone, data, security, energy management and fire alarm will be tied into the Owner's existing system. Refer to the Drawings for conductors and interface requirements.
- C. Instrumentation and controls will be tied into the Owner's existing system. Refer to the Drawings for conductors and interface requirements.

1.5 Quality Assurance

- A. Provide the complete electrical installation in accordance with the National Electrical Code (NFPA 70), Life Safety Code (NFPA 101), and in accordance with applicable local codes. Obtain all necessary permits and have all work inspected by appropriate authorities.
- B. All products shall be designed, manufactured, and tested in accordance with industry standards. Where applicable, products shall be labeled or listed by third party certification agencies.
- C. Industry Standards: Standards organizations and their abbreviations, as used herein, are as follows. Applicable date for industry standards is that in effect on the date of advertisement of the Project.
1. American National Standards Institute (ANSI).
 2. American Society for Testing and Materials (ASTM).
 3. Federal Specifications (FS).
 4. Institute of Electrical and Electronics Engineers (IEEE).
 5. Insulated Cable Engineers Association (ICEA).
 6. National Electrical Manufacturers Association (NEMA).

7. National Fire Protection Association (NFPA).
8. Underwriters Laboratories, Inc. (UL).

1.6 Submittals

- A. Make all submittals in accordance with the requirements of Division 01. Approval drawings consist of shop drawings, product data and other information as noted in the individual equipment sections. Except as noted, submittal information is for approval and equipment may not be installed until submittals have been returned with stamped approval.
- B. Information required "for reference" such as product samples, similar unit test reports and time current curves is for the purpose of determining the suitability of a product, selecting breaker settings, etc. This information is to be submitted at the same time as approval data; however, this information will not be returned, and stamped approval is not required prior to installation.
- C. Except as noted, installation instructions are not required to be submitted. However, it is the Contractor's responsibility to obtain installation information from the manufacturer for all equipment prior to installing the equipment.

1.7 Record Drawings

- A. Furnish record drawings in accordance with the requirements of Division 01. Record drawings consist of submittal data as listed above, operation and maintenance data, and as-built drawings. Record drawings are to reflect the final installation, including any changes during approval, manufacturing tests, and installation.
- B. In addition to other required sets and a digital copy, furnish one set of operation and maintenance data for all apparatus requiring service. This set is to be bound in hardback, 3-ring binder(s) and shall include:
 1. Title page with Project name; installing contractor's name, mailing address, email address, and telephone number; date of installation and warranty period.
 2. Index sheet.
 3. Complete manufacturer's operation and maintenance data with tabs (corresponding to the index) separating each item or system. Include the name, address, and phone number of the nearest sales and service organization for each item.
 4. Coordination Study and written certification that devices have been set in accordance with the study.

- C. As-Built Drawings: Furnish one set of prints maintained at the job site at all times with all changes during construction marked thereon. Include on the as-built drawings sufficient dimensions to permit location of underground conduits.
- D. Submit the results of any tests required in the individual equipment sections.

1.8 Coordination Study

- A. Description: Should any overcurrent protective devices with adjustable time delay and/or other adjustable trip settings be provided or affected by this Project, submit a coordination study with recommended settings for all fault protective devices within the scope of the study. The study shall be prepared by a registered professional engineer, who is not an employee of the Contractor, equipment supplier, or other party having a financial interest in the results of the study. The preparer shall certify that the protective device settings recommended represent a reasonable engineering compromise between equipment protection and selective coordination.
- B. Documentation: Provide tabulations of recommended settings and time current curves showing the degree of coordination obtained with the recommended settings. Also show equipment inrush characteristics and applicable protection limits such as motor stall times, transformer ANSI damage limits, cable heating limits and NEC overcurrent protection requirements. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current seen by the device.
- C. Scope: The study extends from the service entrance equipment down to, and including, the low voltage panelboards.
- D. Fault Currents: Maximum three phase symmetrical values for all major busses will be supplied by the utility company. For high voltage busses, both momentary and interrupting network values shall be supplied. Any other values needed are to be calculated as part of the study. Values supplied by the Engineer are to be used solely for determination of device settings - equipment ratings are as elsewhere noted.
- E. Study Data: The Contractor is responsible for providing field data (conductor materials, existing device types, nameplate information, etc.) to the study preparer. The Contractor is also responsible for providing to the study preparer shop drawing data on new equipment. The study preparer is responsible for obtaining all other needed data (equipment data, time current curves, etc.)
- F. Submittal Requirements: Submit the coordination study prior to, or concurrent with, distribution equipment within the study scope. This is to allow suggested improvements (relay ranges, CT ratios, etc.) that may arise in performing the study to be incorporated prior to equipment fabrication. Review procedures are as specified in Article 1.6 above.

1.9 Arc Flash Study

- A. Description: Submit an arc flash study to facilitate compliance with NFPA 70E, Handbook for Electrical Safety in the Workplace. Arc Flash Study shall be performed using software specifically for the purpose and all calculations shall comply with IEEE 1584.
- B. Documentation: Provide an Arc Flash analysis summary including as a minimum the following information:
 - 1. Equipment name.
 - 2. Equipment voltage.
 - 3. Available fault current (3 phase bolted).
 - 4. Arcing fault current.
 - 5. Protective device operating time.
 - 6. Arc flash boundary (in.).
 - 7. Working distance (in.).
 - 8. Incident Energy (cal/cm²).
 - 9. Protective clothing category.

Provide arc flash warning nameplates for each individual equipment item. Nameplates shall include the wording "WARNING – Arc Flash Hazard. Protective Equipment Required". Nameplate shall also include the analysis data as listed above, settings (where applicable) of the equipment main protective device and a description of protective clothing required.

- C. Scope: Study shall include all electrical distribution equipment from the service entrance equipment down to and including branch circuit panelboards. Individual motor starters and local safety disconnect switches operating at greater than 150 volts AC to ground shall also be included in the study and equipped with warning labels.
- D. Study Data and Submittal Requirements: Fault current and equipment data are as specified above under "Coordination Study" above. Arc Flash Study shall be included with or submitted concurrently with the coordination study.

1.10 Delivery, Storage, and Handling

- A. Ship products to the job site in their original packaging. Receive and store products in a suitable manner to prevent damage or deterioration. Keep equipment upright at all times.

- B. Investigate the spaces through which equipment must pass to reach its final destination. Coordinate with the manufacturer to arrange delivery at the proper stage of construction and to provide shipping splits where necessary.

Part 2 Products

2.1 Materials

- A. Provide only new products of the manufacturer's latest design.

2.2 Substitutions

- A. Where the words "equal to" follow or precede the listed acceptable manufacturers, equal products of other manufacturers are acceptable and request for substitution may be made during submittal stage.
- B. Where the words "or equal" follow the listed acceptable manufacturers, products of other manufacturers must be submitted and approved prior to the Bid, in accordance with the Instructions to Bidders of the Contract Documents.

Part 3 Execution

3.1 Installation

- A. The complete installation is to be accomplished by skilled electrical tradesmen, with certified or suitably qualified individuals performing all special systems installation and testing. All workmanship shall be of the highest quality, sub-standard work will be rejected.
- B. Schedule the work and cooperate with all trades to avoid delays, interferences, and unnecessary work. If any conflicts occur necessitating departures from the Drawings and Specifications, details of departures and reasons therefore shall be submitted immediately for the Engineer's consideration.
- C. Do not stub up conduits prior to receipt of approved shop drawings showing conduit entry locations.
- D. Prior to final inspection, clean all dirt, mud and construction debris from all boxes, cabinets, manholes and equipment enclosures.
- E. Affix arc flash hazard warning labels to all panels within the scope of the Arc Flash Study.

3.2 Certification and Tests

- A. Prior to request for final review, test all systems and repair or replace all defective work. Submit, with request for final review, written certification that all electrical systems are complete and operational.

- B. At the time of final review of electrical work, demonstrate the operation of electrical systems. Furnish labor, apparatus and equipment for systems' demonstration.
- C. After final review and acceptance, turn over to the Owner all keys for electrical equipment locks. Present to the Owner or the Owner's designated representative, demonstrations and oral instructions for proper operation and maintenance of the electrical equipment and systems.

END OF SECTION

Part 1 General

1.1 Scope

- A. This section includes basic materials and methods common to all sections of Division 26.

1.2 Submittals

- A. Submit product data.

Part 2 Products

2.1 Conduit

- A. Rigid Aluminum Conduit: UL 6; ANSI C80.5; minimum size 3/4-inch.
- B. Rigid Steel Conduit: ANSI C80.1; hot dip galvanized; minimum size 3/4-inch.
- C. Intermediate Metal Conduit (IMC): UL 1242; hot dip galvanized; minimum size 3/4-inch.
- D. PVC Coated Conduit: NEMA RN-1 or UL-6 rigid steel conduit with factory applied external 40 mil PVC coating and urethane interior coating. Prior to coating, treat conduit with a heat polymerizing adhesive so the bond between metal and coating is greater than the tensile strength of the coating. Minimum size 3/4-inch.
- E. Electric Metallic Tubing (EMT): ANSI C80.3.
- F. Liquidtight Flexible Conduit: UL listed liquidtight.
- G. Rigid Non-Metallic Conduit: NEMA TC-2; Schedule 40 PVC.
- H. Couplings: Fittings and Conduit Bodies: NEMA FB-1; threaded for rigid aluminum, rigid steel, and IMC; compression type for EMT; compression type with O-ring for liquidtight flexible conduits; slip-fit, chemically welded PVC for rigid non-metallic conduit.

2.2 Conductors

- A. Building Wire: NEMA WC-5; single conductor; 98 percent conductivity copper; 75/90 degrees C; 600 volt PVC insulated with nylon jacket; type THWN/THHN for sizes #1 AWG and smaller. Sizes larger than #1 AWG are XLP insulation type XHHW. Minimum size #12 AWG.
- B. Motor Feeders: Conductors between motors and adjustable speed drives are XLP insulation type XHHW regardless of size.

- C. Control Wire: Same as building wire except minimum size #14 AWG.
- D. Instrumentation Signal Cables: #16 AWG stranded tinned copper conductors; 600 volt polyethylene insulation; twisted pair or three conductor construction; 100 percent coverage aluminum polyester shield; #18 stranded tinned copper drain wire; vinyl outer jacket; UL listed.
- E. Category 6 Ethernet Cables: Category 6 Advanced (CAT 6A), copper conductor, 300 volt insulation, rated 60 degrees C, individual conductors twisted together and covered with a PVC jacket; UL listed.
- F. Fiber Optic Cables: Multimode, 62.5/125 OM1, outdoor, tight buffered fiber optic cable meeting functional requirements of ICEA-S-87-640, TIA-568 and TIA-598; rated -40 degrees C to +85 degrees C; polyethylene outer cable jacket. Provide 6 strands minimum. Equip all strands with ST connectors (or other connector type coordinated with the Owner's existing fiber switch equipment) in termination cabinets, patch panels and associated enclosures.

2.3 Boxes

- A. Sheet Metal Boxes: NEMA OS-1; galvanized steel.
- B. Cast Boxes: NEMA 250; NEMA Type 4, galvanized cast iron box and cover with threaded hubs, neoprene gasket, stainless steel cover screws, UL listed as raintight. Provide flat-flanged type for surface mounting.
- C. Corrosion Resistant Boxes: UL 508, 316 stainless steel, NEMA Type 4X. For boxes larger than 12-inches in any dimension provide hinge on one side and stainless steel clamp latches (equal to Hoffman A-L23SS) on the other side(s). Equal to Hoffman Bulletin A-4.

2.4 Wiring Devices

- A. Switches: FS W-S-896, 20 amp, 120-277 volt, gray handle.
- B. Receptacles: NEMA WD-1; 5-15R; nylon face; gray. Exceptions: Provide specific use receptacles where indicated. Provide 5-20R receptacles for branch circuits serving one device.
- C. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5-milliamps; 125-volt, configuration 5-20R.
- D. Cover Plates (Finished Areas): Type 302 stainless steel, 0.030 inch thick minimum, satin finish.
- E. Indoor Corrosion Resistant (NEMA 4X) Cover Plates: Type 302 stainless steel, specification grade, gasketed, with silicone rubber mat, equal to Pass & Seymour 4515 or 4151FS for toggle switches. Cast aluminum, gasketed, equal to Pass & Seymour CA Series for receptacles. For heat tape, instruments, or other devices

which are continuously plugged in, provide die cast aluminum, suitable for wet locations while-in-use, equal to Hubbell WP26.

- F. Outdoor Weatherproof (NEMA 3R and NEMA 4X) Cover Plates: Stainless steel, specification grade, gasketed, equal to Sierra WP Series for toggle switches. Die cast aluminum, suitable for wet locations while in use, equal to Hubbell WP26 for all outdoor receptacles.

2.5 Disconnect Switches

- A. Disconnect Switches: UL-98 and NEMA KS-1; heavy duty, quick make, quick break type; horsepower and i2t rated. Provide lever type operating handle directly connected to the switch mechanism; rocker types are not acceptable. Include padlocking provisions and nameplate clearly indicating "ON" and "OFF" positions. Equip all switches with a ground lug and, where neutral conductors are scheduled, provide insulated neutral lugs. Where indicated on the Drawings provide DPDT auxiliary contacts rated 10 amps at 120 VAC minimum.
- B. Fusible Switches: Equip with rejection clips for fuse types noted.
- C. Enclosure: Stainless steel meeting NEMA 3, 4X and 12 requirements for process areas and wet locations or outdoors. Sheet metal; NEMA 1 for indoor dry locations only.
- D. Acceptable Manufacturers: ABB/General Electric, Eaton, Siemens, or Square D.

2.6 Individual Motor Starters

- A. Manual Starters: NEMA ICS-2; general purpose type; trip-free mechanism; with overload relays. Provide pushbutton operation for integral horsepower sizes, and toggle switch or lever for fractional sizes.
- B. Magnetic Starters: NEMA ICS-2; NEMA size 0 minimum; magnetically held contactor with field replaceable coil and contacts; bimetallic or melting alloy overload relay, manually reset. Starter shall be rated in accordance with NEMA size designations; fractional sizes and ratings per IEC recommendations are not acceptable.
- C. Magnetic Starter Controls: All controls are 120 volts. Equip each starter with a control power transformer fused on the primary and secondary. Provide starter overload relay auxiliary contacts for red run light, green stop light and amber overload light on the enclosure door. Provide one spare normally open starter auxiliary contact, and door mounted start-stop pushbuttons or hand-off-auto selector switch as indicated.
- D. Combination Starters: Molded case circuit breaker rated 42,000 AIC.

- E. Enclosure: Stainless steel meeting NEMA 3, 4X and 12 requirements for process areas and wet locations or outdoors. Sheet metal; NEMA 1 for indoor dry locations only.
- F. Acceptable Manufacturers: Allen-Bradley, ABB/General Electric, Eaton, Siemens, or Square D.

2.7 Contactors

- A. Control Relays: NEMA A600; heavy duty, machine tool type convertible contacts; electrically held 120 volt coil. Equal to Allen-Bradley Bulletin 700 Type P.
- B. General Purpose Contactors: NEMA ICS-2; electrically held; 2-wire control; 120 volt coil. Size and number of contacts as indicated.
- C. Lighting Contactors: NEMA ICS-2; mechanically held; 3 wire control; 120 volt coil. Size and number of contacts as indicated.
- D. Enclosure: Stainless steel meeting NEMA 3, 4X and 12 requirements for process areas and wet locations or outdoors. Sheet metal; NEMA 1 for indoor dry locations only.
- E. Pushbuttons, Selectors and Pilot Lights: 30mm, 600 volt, heavy duty, factory sealed; NEMA 4/4X equal to Allen-Bradley Bulletin 800H for contactors in NEMA 4X enclosures or NEMA 4/13 equal to Allen-Bradley Bulletin 800T for contactors in NEMA 12 enclosures. Provide LED lamps in pilot lights.
- F. Acceptable Manufacturers: ASCO, ABB/General Electric, Eaton, Siemens, or Square D.

2.8 Control Stations

- A. Pushbuttons, Selectors and Pilot Lights: 600 volt, heavy duty, factory sealed.
- B. Enclosure: Stainless steel meeting NEMA 4X and NEC Class I, Division 2, Group C and D requirements.
- C. Acceptable Manufacturers: Equal to Allen-Bradley Bulletin 800H.

2.9 Fuses

- A. Fuses: Current limiting, non-renewable type, rated 200,000 AIC, with rejection feature; Class J or as required by load for ratings 600 amp and below and Class L for ratings 601 amp and above.
- B. Acceptable Manufacturers: Bussmann, Chase-Shawmut, or Littelfuse.

2.10 Plywood Backboards

- A. Backboards: Grade BC plywood, 3/4-inch thick.

2.11 Supporting Devices

- A. Support Channel: Stainless steel, galvanized or painted steel.
- B. Hardware: Stainless steel, galvanized or zinc plated steel.
- C. Threaded Rods: 3/8-inch diameter, stainless steel or galvanized steel.
- D. Fabricated Structural Support Stands: Material and dimensions as shown on Standard Details on the Drawings.
- E. Where outdoor, wet, corrosive or NEMA 4X areas are indicated, use stainless steel channel, straps, hardware and rods. Additional material requirements are indicated on the Drawings.

2.12 Electrical Identification

- A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- B. Wire and Cable Markers: Plastic, split sleeve or tubing type.

2.13 Grounding

- A. Bare Conductors: ASTM B-8; stranded; hard drawn copper. Size unless otherwise noted is #4/0 AWG.
- B. Ground Rods: UL 425H; 5/8-inch x 8 feet; high strength steel core with metallically bonded copper jacket.
- C. Exothermic Weld Connection System: System shall meet the applicable requirements of ANSI IEEE Standard 80 "IEEE Guide for Safety in AC Substation Grounding" and IEEE Standard 837 IEEE "Standard for Qualifying Permanent Connections Used in Substation Grounding". Independent test data showing conformance to IEEE Std. 80 and IEEE Std. 837 shall be readily available. The system shall be approved by an OSHA Nationally Recognized Test Laboratory such as Underwriters Laboratories to ANSI UL 467 "Grounding and Bonding Equipment". Connections shall be suitable for exposure to the elements of direct burial in earth or concrete without degradation over the lifetime of the grounding system. Molds shall be made of graphite material capable of withstanding high temperatures that are capable of providing an average life of not less than fifty separate exothermic welds. Starting material (where used) shall consist of aluminum and copper and iron oxides. It shall not contain phosphorous, magnesium or any caustic, toxic or explosive substances. Low voltage battery starting (where used), shall use an electric ignition system that does not use starting material. Weld metal used for grounding connections shall contain copper oxide, aluminum and

not less than 3% tin as the wetting agent. Weld metal used for cathodic connections shall not contain tin but shall contain vanadium. Equal to Erico Products (Cadweld).

- D. Mechanical Connectors: UL 486B listed; split-bolt, saddle, or cone screw type; tin-plated, high strength copper alloy with spacer to separate dissimilar materials; suitable for all combinations of connections of copper, aluminum, ACSR, AAAC, 5005, and steel.
- E. Compression Connectors: Irreversible compression type using wrought copper extrusion material. Tools and dies specific for use with same connectors. Equal to Burndy Hyground.
- F. Ground Test Well: 10-inch diameter Schedule 40 PVC well with four slots, 3/16-inch thick steel cover with corrosion-resistant coating. Equal to Harger 360P42

Part 3 Execution

3.1 Conduit

- A. Unless otherwise noted, use only rigid aluminum conduits where exposed and not in direct contact with concrete. Use galvanized rigid steel or IMC where encased in concrete slabs or walls. EMT may be used where concealed above ceilings or in hollow spaces of interior dry walls, exposed in electrical rooms and for telephone wiring.
- B. Provide flexible metal conduit for connections to fixtures in suspended ceilings. Provide liquidtight flexible conduit for connections to motors, transformers, and other vibrating equipment. Maximum length is 3 feet unless approved by the Engineer.
- C. Use suitable equipment for all bends. Crushed or deformed conduits may not be installed. Cut threaded ends square and ream to remove burrs. Paint threads with zinc compound.
- D. Run exposed conduits parallel or perpendicular to building surfaces. Route conduits in slabs below top reinforcing and above bottom reinforcing. Support conduits above ceilings to the building structure independent of the ceiling support system. Coordinate with other trades and avoid hot piping when possible. Where unavoidable, maintain 3-inch clearance when crossing and 12-inch clearance when paralleling hot pipes. Cap exposed conduit ends during construction.
- E. Support conduits to prevent distortion of alignment by wire pulling operations. Fasten single conduits with one-hole malleable iron straps. For multiple runs use channel and clamps. Wire, perforated pipe straps and the like are not acceptable support means.
- F. Support conduit at a maximum of ten feet on center and within three feet of each box, cabinet, or fitting. Hang trapeze assemblies with threaded rods not less than 3/8-inch diameter. Remove all temporary supports prior to pulling conductors.
- G. Do not support conduits from electrical distribution equipment or control panels.

- H. Conduits left empty for future use shall have a 200 pound tensile strength polyolefin line pulled through and tied off at each end.
- I. All connections are to be wrench tightened and electrically continuous. No running threads are permitted. Provide clamp backs for all raceways on exterior or damp surfaces to prevent the raceway from bearing directly on the damp surface.
- J. Use integral conduit hubs for fastening conduit to cast boxes. Use cast metal hubs for fastening conduit to sheet metal boxes in damp or wet locations. Use conduit bodies to make sharp changes in direction. For sizes 2-inches and larger, use "LBD" or similar fittings to permit a straight pull from either direction. In no case shall a fitting be used which results in bending radius too small for the cable.
- K. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.
- L. PVC Coated Conduit: Exercise care not to damage the coating during cutting, threading, bending, and assembly. Follow the manufacturer's installation instructions. Use vise jaws, bending equipment, strap wrenches, and other tools which are specifically designed for coated conduits. Do not use chain vise, pipe wrench, channel locks or the like. Nicks or small damaged areas (1/2-inch maximum) may be repaired with a manufacturer approved compound. Replace items if coating is damaged in excess of 1/2-inch. Fill space between PVC coating and reducing fittings with silicone sealant.
- M. Rigid nonmetallic conduit may be used for underground concrete encased duct banks where not located within hazardous areas. Exception: Use rigid steel or IMC conduit for analog signal circuits; 4 to 20 mA and AC or DC signals less than 25 volts.
- N. Where PVC conduit is indicated, make a transition to rigid steel within concrete encasement below grade or slab and continue above with rigid metal conduit. Provide bell ends in handholes.
- O. Use PVC coated conduits where conduits are in direct contact with the earth.
- P. Perform excavation for underground conduits in accordance with applicable OSHA requirements, including suitable bracing and shoring where required.
- Q. Excavation includes all excavation of trenches, no matter what the substance encountered, and disposal of excess material.
- R. Perform trench excavation by open cut. The top portion of the trench may be excavated with vertical or sloping sides to any width within the construction easement which will not cause unnecessary damage to adjoining structures, roadways, pavements, utilities, trees, or private property.
- S. Install top of buried conduit minimum 18-inches below finished grade with plastic warning tape 12-inches below finished grade.

- T. Use suitable separators and chairs installed not greater than four feet on centers to provide conduit spacing as indicated. Securely anchor conduit to prevent movement during fill placement.
- U. Where conduit passes beneath footings or slabs resting on grade excavate to provide a minimum of 6-inch clearance between the conduits and the structure. Backfill to the base of the structure.
- V. Construct duct banks with 3,000 psi concrete. Provide reinforcing as indicated.

3.2 Conductors and Connectors

- A. Use only stranded conductors. Exceptions: Solid conductors may be used for receptacle branch circuit wiring, sizes #10 and #12 AWG only.
- B. Use 90 degree C insulated conductors for all lighting circuits. Use 75 degree C insulated conductors elsewhere unless Drawings note otherwise.
- C. Do not pull conductors until the conduit system is complete. Swab conduits prior to pulling and use pulling compound for all pulls. Do not exceed the manufacturer's pulling tension.
- D. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- E. Avoid all unnecessary splices. Where unavoidable, make splices in outlet boxes or pull boxes.
- F. Identify all conductors throughout the electrical system. For control and signal circuit, use numbered wire markers at all terminals. For power circuits color code per NEC.
- G. Make connections to circuit breakers, disconnect switches, panel mains, etc. with solderless lugs. Use mechanical connectors for stranded conductors.
- H. Continuity Tests: Ring all conductors for continuity and replace any open conductors.
- I. Ground Fault Tests: Meggar all feeder circuits for grounds. Compile and submit a list of meggar readings. Replace all conductors measuring less than 2 megohms to ground.
- J. Fiber Optic Cable Installation:
 - 1. Installation shall comply with EIA/TIA Standards 568 and 569.
 - 2. Fiber-optic cable shall be continuous from component to component as shown on the Drawings. Intermediate fiber splices shall not be allowed.
 - 3. All cable shall be installed in conduit indoors and conduit in concrete duct banks outdoors.

4. Inspect fiber-optic cable conduits or raceways prior to installing cables. Notify the Engineer of any conditions, which would prevent installation of the specified cables, before proceeding with the installation. Rod and swab out conduits or raceways prior to installing cables.
5. Install cables prior to attachment of connectors.
6. Install cables by directly pulling on the strength member.
7. Prior to installation, lubricate cables with lubricants specially formulated for fiber-optic cabling jackets. During installation, the Contractor shall not exceed cable manufacturers specifications for tensile strength and bending radius.
8. Splices shall not be allowed unless approved by the Engineer. If necessary, splices shall be made in designated patch panel enclosures above ground.
9. Provide breakout kits, signal transceivers, power supplies, patch panels, pigtails and jumpers as required and as specified to install a complete data highway communications network.
10. Provide support cables in riser conduits as required by the National Electric Code.
11. The cable manufacturer shall approve all installation tools and materials.
12. Identify and tag each cable in duct banks, junction boxes or manholes using permanent nylon/plastic tie-wrap tags with waterproof markings.
13. Label each cable, buffer tube and fiber with permanent waterproof typewritten tags.
14. Coordinate connector types with fiber switch equipment.

K. Fiber optic Cable Field and Functional Testing

1. The Contractor shall make the following site tests before removing the cable from the reels:
 - a. Determine attenuation losses of each fiber from end-to-end. Use an optical time domain reflectometer (OTDR) to capture and record all readings.
 - b. Submit to the Engineer all test data, test equipment used, calibration standards and test results.
2. The Contractor shall make the following field tests after the cable and connector installation is complete:
 - a. All fiber-optic cables and related connectors shall be tested for performance and loss after the cable installation and connector

termination is complete to certify that at least a 3dB power safety margin is obtained between all transmitters and receivers.

- b. Test data for each fiber and safety margin calculations for each fiber path shall be provided to the Owner and Engineer after installation to verify conformance with the specification.
- c. The following tests shall be performed as a minimum but not limited to:
 - 1) Visually inspect terminal connectors for out-of-round condition and surface defects such as microchips and cracks using a 200X (minimum) inspection microscope.
 - 2) Check optical continuity of each fiber from terminal to terminal. Use test equipment as specified herein and provide certification reports for each fiber in each cable.
 - 3) Verify the calculated attenuation power losses of each fiber from both the transmit and receive terminals of each data communication loop (both directions) using an OTDR.
 - 4) Submit to the Engineer all test data, test equipment used, calibration standards and test results.

3.3 Boxes

- A. Provide boxes as shown on the Drawings and as required for splices, taps, wire pulling, and equipment connections. Support boxes independently of conduit. Provide knockout closures for unused openings.
- B. Box locations shown on the Drawings are approximate unless dimensioned. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and other furnishings. Locate outlet boxes to permit handicap access per ANSI A117.1. Where receptacles are indicated 18-inches above finished floor, dimension is to the bottom of the box. At the option of the Owner's representative, any outlet may be relocated by up to ten feet before it is permanently installed, without incurring additional cost. Install adjacent devices at the same elevation in a common box with one face plate. Install adjacent devices at different elevations in one vertical line.
- C. Unless otherwise noted, use only cast outlet boxes. Sheet metal boxes may be used where concealed above ceilings or in dry walls, exposed in electrical closets, and for telephone wiring.
- D. Field drill conduit holes in tap, junction and pull boxes so as to afford the maximum bending radius for the conductors.

3.4 Wiring Devices

- A. Secure devices to outlet boxes without depending on device plates to pull them tight. Install a bonding jumper between all devices and outlet boxes. Install receptacles with ground pole down.
- B. For cord and plug connected equipment, coordinate receptacle configuration with equipment supplied.

3.5 Disconnect Switches

- A. Provide switches with voltage, ampere, and number of poles as indicated on the Drawings.
- B. Switches are non-fused type, unless Drawings note otherwise, or the switch is used as a disconnect for an item of equipment with a maximum fuse size designated on the nameplate. In such cases, provide fusible type with appropriate fuse. If fusible switches protect conductors with an ampacity less than the rating of the switch, provide a nameplate on the inside front cover of the switch designating the maximum allowable fusing.
- C. Install switches so they are rigidly supported and readily accessible. Provide stainless steel mounting channel or phenolic spacers to give nominal 1/2-inch separation from concrete walls in wet or damp locations.
- D. For disconnect switches serving motors with space heaters, provide lamecoid nameplate engraved "WARNING – Motor space heater energized with switch open".

3.6 Individual Motor Starters

- A. Select and install heater elements in motor starters to match installed motor characteristics. Do not use NEC motor full load ampere data for heater selection.
- B. Provide a typed label inside each motor starter enclosure door identifying the motor served and listing the motor nameplate data. Provide an engraved nameplate on the exterior of the enclosure door identifying the motor served, the horsepower, voltage and phase rating.
- C. Install starters so they are rigidly supported and readily accessible. Provide stainless steel mounting channel or phenolic spacers to give nominal 1/2-inch separation from concrete walls in wet or damp locations.

3.7 Contactors

- A. Install timer and lighting controls for contactors as indicated.
- B. Install indicator lights and selector switches in enclosure door as indicated.

3.8 Control Stations

- A. Install control stations so they are rigidly supported and located so as not to impair access to equipment for maintenance.

3.9 Fuses

- A. Equip all fusible devices with fuses. Replace all blown fuses up to final acceptance of the Project. At the completion of the Project, turn over to the Owner spare fuses for each type and size installed; six each for ratings 60 amps and below, and three each for ratings above 60 amps.

3.10 Plywood Backboards

- A. Where the use of metallic support channel is impractical due to structural conditions or dictated by the size and quantity of wall-mounted devices, panels cabinets, etc., provide plywood backboards for surface mounted electrical distribution equipment in areas such as mechanical rooms, electrical closets, and equipment rooms where support is required to span structural voids or to reinforce wall material. Secure backboards to the building structure and paint with two coats of exterior latex paint. Coordinate paint color with Owner.

3.11 Supporting Devices

- A. Fasten hanger rods, support stands, conduit clamps, etc. to building structure using expansion anchors, beam clamps, or means indicated on the Drawings.
- B. Unless noted otherwise, use beam clamps on exposed metal structure; toggle bolts or hollow wall fasteners in hollow masonry, plaster, precast hollow-core planks, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or adhesive anchors on cast-in-place concrete walls and slabs; self-drilling inserts in precast hollow-core planks; and sheet metal screws in sheet metal studs.
- C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.
- D. Do not attach to precast double-tee flanges or the bottom of the stem. Use pre-installed holes in side of stem.
- E. Do not attach to bottom side of cast-in-place concrete beam.
- F. Do not attach to cast-in-place concrete columns.
- G. Do not use powder-actuated anchors.
- H. Do not use perforated straps or wire.

- I. Make all supports from the structure, not the work of other trades. Do not drill or cantilever from structural steel members. Install supports so as not to weaken the structure.
- J. Fabricate supports from structural metal channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- K. Install free-standing electrical equipment on concrete pads. Anchor to concrete pad in accordance with the applicable Structural Section.
- L. Install surface-mounted cabinets and panelboards on channel or plywood backboard with minimum of four anchors.
- M. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- N. Cutting, drilling, nicking, or damaging reinforcing steel or pre-stressed tendons is not permitted. Therefore, when drilling into any existing concrete for anchorage, Contractor shall locate existing reinforcing steel and/or pre-stressed tendons using concrete imaging equipment, such as cover meter based on pulse induction method, unless prior approval is obtained from the Engineer. Provide minimum spacing of 3 inches between anchors and existing reinforcing steel/pre-stressed tendons. Notify Engineer immediately if the location of the anchors would not allow 3-inch spacing to reinforcing steel/pre-stressed tendons.
- O. If drilling results in concrete spalling, spalling shall be repaired by the trade performing the drilling.
- P. All anchors shall conform to the applicable Structural Section for Concrete Anchoring Systems.
- Q. Refer to the applicable Structural Section for seismic requirements.

3.12 Electrical Identification

- A. Provide nameplates for all switchboards, panelboards, transformers, disconnect switches, individual motor starters, and other items of electrical distribution equipment. Engrave with the equipment identification as indicated; and the voltage, current and interrupting rating. Attach nameplates with screws or rivets; adhesives are not acceptable. Exception: Two-part epoxy glue may be used for NEMA 4/4X enclosures.
- B. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams for control wiring.

3.13 Grounding

- A. Except as noted, use insulated ground conductors only where installed in a raceway. Use bare conductors for ground rod connections and bonding of buildings, structures etc. Where a bare conductor is installed in a raceway use only non-metallic raceways; do not install bare conductors in metallic raceways.
- B. Drive ground rods so the top is 3 to 6-inches below finished grade. If rock is encountered then rods may be driven at an angle or grounding plates, as approved by the Engineer, may be used.
- C. Where bare conductors emerge from concrete encasement, provide a 4-inch length of Schedule 40 PVC conduit set in the concrete to protect the conductor.
- D. Route a bare conductor through each duct bank. Connect to building ground grid.
- E. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- F. Notify the Owner's representative at least one week in advance that the ground system for each building or structure is ready for inspection. Obtain written notice to proceed before filling trenches, pouring slabs, or otherwise covering the work.

END OF SECTION

Part 1 General

1.1 Scope

- A. Dry type two winding transformers.

1.2 Submittals

- A. Submit product data. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.3 Delivery, Storage and Handling

- A. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- B. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

Part 2 Products

2.1 Acceptable Manufacturers

- A. Dry type transformers shall be equal to ABB/General Electric, Eaton, Hevi-Duty, Siemens, or Square D.

2.2 Dry Type Transformers

- A. Dry Type Transformers: NEMA ST-20; factory-assembled, air cooled dry type transformers; ratings as indicated. Transformers are two winding power type. Three phase units are connected delta primary and wye secondary. Scott or Tee connections and autotransformers are not acceptable.
- B. Insulation: 220 degrees C, 150 degree C rise for ratings 30 kVA and larger; 185 degrees C, 115 degree C rise for ratings below 30 kVA.
- C. Taps: Two, 5 percent below rated primary for ratings 15 kVA and smaller; six, 2-1/2 percent two above and four below rated primary for ratings larger than 15 kVA.
- D. Enclosure: Painted sheet metal meeting NEMA 1 requirements. For transformers located outdoors, provide rain shield meeting NEMA 3R requirements.

- E. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap. Equip with ground lug capable of accepting up to one 4/0 AWG copper conductor.
- F. Mounting: Transformers 75 kVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA shall be suitable for floor or trapeze mounting.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.

Part 3 Execution

3.1 Installation

- A. Set transformer plumb and level. Clear walls and ceilings by at least 6-inches to allow for air circulation.
- B. Use flexible conduit, two-foot minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

3.2 Field Quality Control

- A. Check for damage and tight connections prior to energizing transformer.
- B. Measure secondary voltage under normal load conditions and make appropriate tap adjustments.

END OF SECTION

Part 1 General

1.1 Scope

- A. Main switchboard.

1.2 Submittals

- A. Shop Drawings: Front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and equipment short circuit rating.
- B. Protective Device Trip Settings: Provide tabulation of each adjustable trip device indicating "As Found" and "As Set" conditions.

1.3 Record Drawings

- A. Shop Drawings: As listed in Article 1.2, corrected to reflect the equipment as-built.
- B. Operation and Maintenance Data: Spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.4 Delivery, Storage and Handling

- A. Arrange shipping splits as required for installation. Individually wrap each section and mount on shipping skids.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with NEMA PB-2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

Part 2 Products

2.1 Acceptable Manufacturers

- A. Switchboards shall be manufactured by ABB/General Electric, Eaton, Siemens, or Square D.

2.2 Switchboard Construction and Ratings

- A. Switchboard: Factory-assembled; dead front; metal-enclosed; front accessible; self-supporting switchboard assembly conforming to NEMA PB-2; complete from incoming line terminals to load-side terminations. Provide UL service entrance label.
- B. Switchboard Electrical Ratings and Configurations: As indicated.
- C. Main Section Device: Individually mounted.
- D. Distribution Section Devices: Panel mounted.
- E. Bus: Copper with tin plating, sized in accordance with NEMA PB-2. Provide a copper ground bus through the length of the switchboard.
- F. Enclosure: NEMA PB-2 Type 1 - General Purpose. Sections align at the rear for mounting against a wall.
- G. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.3 Switching and Overcurrent Protective Devices

- A. Molded Case Circuit Breakers: NEMA AB-1; FS W-C-375; provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
- B. Main Circuit Breakers: NEMA AB-1; insulated case; two-step stored energy operating mechanism; manually operated; stationary mounted; 600 amp minimum frame size. Provide integral solid state trip device with adjustable current setting (50-100 percent of frame size), long time delay, short time pick-up, short time delay and fixed (hi-set) instantaneous. Provide zero sequence ground fault with adjustable pick-up and time delay.

2.4 Instruments and Sensors (Switchboard Mains)

- A. Circuit Monitor: Microprocessor based unit for measuring multiphase variables including amps, volts, VARS, watts, volt-amps, power factor, demand values and harmonic distortion indication. Communications: ModBus RTU protocol; digital and analog inputs and outputs; RS232 port on front; RS485 ports on rear. Equal to General Electric Power Quality Meter.
- B. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden an accuracy consistent with connected metering and relay devices, 60 Hertz.

- C. Potential Transformers: ANSI C57.13; 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.5 Surge Protective Devices

- A. Surge protective devices (SPD) and all components shall be designed, manufactured, tested and listed in accordance with the latest edition of ANSI/UL 1449 4th Edition.

- B. UL designation: Type 2.

- C. Electrical Requirements

1. Maximum Continuous Operating Voltage (MCOV): Not less than 115% of the nominal system voltage.
2. Protection Modes: Protect all modes (L-L, L-N, etc.), of the electrical system being utilized with a minimum of seven mode protection.
3. Nominal Discharge Current (In): 20kA.
4. Voltage Protection Rating (VPR) shall not exceed the following:

Voltage Rating	L-N	L-G	N-G	L-L
208Y/120-240	700	700	700	1,200
480Y/277	700	700	700	2,000
240Δ	n/a	1,500	n/a	3,000
480Δ	n/a	1,500	n/a	2,000

5. Surge Current Capacity: ANSI/IEEE C62.41 Category C; 240 kA per phase, 120 kA per mode.
6. EMI/RFI noise suppression: -50db attenuation at 100 kHz tested per MIL-STD 220B.

- D. SPD Design

1. Unit shall incorporate thermally protected metal-oxide varistors (MOVs).
2. All internal components shall be hardwired and soldered; no plug-in modules will be permitted.
3. Provide LED status for each protected phase, a form C dry contact for remote status, and a surge event counter.
4. SPD shall be mounted integral to the electrical distribution equipment.

Part 3 Execution

3.1 Installation

- A. Install switchboard on concrete pad in locations shown on Drawings in accordance with manufacturer's written instructions and NEMA PB-2-1. Anchor to existing concrete pads with expansion anchors or embed support channel into new concrete pads and attach to channel with bolts designed specifically for the application. Drilling into reinforcing steel is not permitted. Therefore, when drilling into any concrete for anchorage, Contractor shall locate reinforcing steel using concrete imaging equipment such as cover meter based on pulse induction method, unless prior approval is obtained from the Engineer. Provide minimum spacing of 3 inches between anchors and reinforcing steel. Notify Engineer immediately if the location of the anchors will not allow 3-inch spacing to reinforcing steel. If drilling results in concrete spalling, spalling shall be repaired by the trade performing the drilling.
- B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

3.2 Field Quality Control

- A. Inspect completed installation for physical damage, proper alignment, anchorage and grounding.
- B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each. Test voltage shall be 1,000 volts, and minimum acceptable value for insulation resistance is 2 megohms.
- C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.
- D. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

Part 1 General

1.1 Scope

- A. Panelboards.

1.2 Submittals

- A. Submit shop drawings.

Part 2 Products

2.1 Acceptable Manufacturers

- A. Equipment shall be manufactured by ABB/General Electric, Eaton, Siemens, or Square D.

2.2 Panelboards

- A. Panelboards: NEMA PB-1; UL 67.
- B. Rating: Voltage and ampere ratings are shown on the Drawings. Unless otherwise indicated interrupting ratings (RMS symmetrical) are 14,000 amps for 480 volt panelboards and 10,000 amps for 240 and 208 volt panelboards.
- C. Boxes: Code gauge galvanized steel; sized to accommodate devices indicated and afford wire bending space in accordance with NEC requirements.
- D. Fronts: Surface or flush as indicated, door-in-door construction, finished in light grey enamel over a rust inhibitor. Furnish flush lock for fronts less than 48-inches high and vault type handle with three point catch for fronts 48-inches and higher. Key all locks alike.
- E. Enclosure: Where indicated provide NEMA 3R painted steel enclosure in lieu of box and front. Provide filler panel inside enclosure to prevent access to exposed live parts when door is open. Filler panel shall be finished in light grey enamel over a rust inhibitor. Provide lockable handle keyed to match locks on panel fronts.
- F. Bus: Copper, arranged for bolt-on circuit breakers. Furnish insulated neutral bus and ground bus with main lug bonded to the box.
- G. Circuit Breakers: NEMA AB-1; molded case type, thermal-magnetic trip with internal common trip on multipole breakers. Provide breaker fully rated for interrupting ratings noted; series ratings are not acceptable.
- H. Ground Fault Protection: Where indicated with "GFI Circuit Breaker", provide UL Class A ground fault circuit interrupter tripping at 5 mA for circuits that supply

receptacles. Provide UL listed ground fault interrupter tripping at 30 mA for equipment ground fault protection for circuits that supply electric heat tracing.

- I. Provide engraved nameplates giving the voltage rating and panel designation as indicated. Provide a UL service entrance label for panelboards used as service entrance equipment.

2.3 Surge Protective Devices (Factory Installed)

- A. Surge protective device (SPD) and all components shall be designed, manufactured, tested and listed in accordance with the latest edition of ANSI/UL 1449 4th edition.

- B. UL Designation: Type 2.

- C. Electrical Requirements

1. Maximum Continuous Operating Voltage (MCOV): Not less than 115% of the nominal system voltage.
2. Protection Modes: Protect all modes (L-L, L-N, etc.), of the electrical system being utilized with a minimum of seven mode protection.
3. Nominal Discharge Current (In): 20kA.
4. Voltage Protection Rating (VPR):

Voltage Rating	L-N	N-G	L-G	L-L
208Y/120-240	700	700	700	1,200
480Y/277	700	700	700	1,200
240Δ	-	-	1,500	3,000
480 Δ	-	-	900	1,800

5. Surge Current Capacity: ANSI/IEEE C62.41 Category C; 80kA per phase, 40kA per mode.
6. EMI/RFI Noise Suppression: -50db attenuation at 100kHz tested per MIL-STD 220B.

- D. SPD Design

1. Unit shall incorporate thermally protected metal-oxide varistors (MOVs).
2. All internal components shall be hardwired and soldered; no plug-in modules will be permitted.
3. Provide LED status for each protected phase, form C dry contact for remote status and surge event counter.
4. SPD shall be mounted integral to the electrical distribution equipment.

2.4 Surge Protective Devices (Field Installed)

- A. Where “plug-on” surge protectors are indicated on the Panelboard Schedule, provide plug-on or bolt-on secondary surge arrester meeting ANSI/IEEE C62.11-1993. Surge protector shall have operational status LED indicator and shall consume no more than two individual pole spaces for single-phase installations and no more than three individual pole spaces for three-phase installations.

Part 3 Execution

3.1 Installation

- A. Install boxes so they are rigidly supported and correctly aligned. Anchor panelboards to the wall or support stand in accordance with the applicable Structural Section of these Specifications using a minimum of four anchors. Select mounting height so that the centers of the highest grips or operating handles are not higher than 6-feet 7-inches (2.0 meters) nor lower than 24-inches above the floor or working platform.
- B. To the extent possible, extend conduits directly to panelboards without using junction boxes or wireways.
- C. Prior to energizing panelboards clean out construction dirt and debris. Paint any scratches on the trims or dead front barriers. Meggar each phase to phase and ground to ensure that no short circuits exist.
- D. Adjust panel barriers so that no openings occur between them and the panel front. Provide filler plates and plugs as necessary to maintain dead front integrity.
- E. Type directory cards with circuit loads and/or area served. Note spare circuits in pencil.

3.2 Field Quality Control

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

END OF SECTION

Part 1 General

1.1 Scope

- A. Interior luminaires and accessories.
- B. Exterior luminaires and accessories.

1.2 Submittals

- A. Submit product data. Include dimensions, accessories, installation and construction details, and photometric data. Any submittal containing lighting fixtures other than those specifically listed in the Fixture Schedule shall include an illumination study clearly indicating foot candle levels for the entire illuminated region. Maintained average illumination levels and uniformity of proposed layout must meet or exceed the combined performance of equipment listed in the Fixture Schedule and arrangement indicated on the Drawings for proposed equipment to be considered for substitution. Engineering design data will not be available to the Contractor. Therefore, a comparative illumination study shall also be submitted using the "as designed" fixtures. Both studies shall utilize identical parameters (including, but not limited to, luminaire mounting height, luminaire orientation, reflectances, light loss factors and calculation grid). No substitutions will be considered without accompanying lighting design data.

1.3 Delivery, Storage, and Handling

- A. Handle fixtures and metal poles carefully to prevent breakage and damage to finish.

Part 2 Products

2.1 Acceptable Manufacturers

- A. Fixtures: Equal to fixtures shown on Fixture Schedule on the Drawings.

2.2 Interior Luminaires and Accessories

- A. Provide fixtures as shown in the Lighting Fixture Schedule on the Drawings.
- B. Where flat acrylic lenses are specified, use 100 percent virgin acrylic, pattern 12; 0.125-inch thickness.
- C. Provide fixture housings and frames to match the ceilings called for on the Architectural Drawings.
- D. Recessed Luminaires: Prewired type with thermal protection.
- E. LED Luminaires: Pre-wired, with integral ballast/driver.

2.3 Exterior Luminaires and Accessories

- A. Provide low temperature ballasts/drivers, with reliable starting to -20 degrees F.

2.4 Led Luminaires

- A. Light Color: 4,000 degrees K unless otherwise indicated.
- B. Certifications: UL or ETL Listed and labeled.
- C. Color Rendering: Minimum 80CRI.
- D. Warranty: 5-year minimum.
- E. Testing: LM-79, LM-80 and TM-21 standards.
- F. Lumen Maintenance: 70% lumen output for 50k hours.
- G. Power Factor: 0.9 or better.
- H. Drivers: Suitable for use with voltage specified. Provide drivers dimmable to 10% where indicated. Dimmers shall be specifically listed by the fixture manufacturer for use with the drivers supplied.

2.5 Lighting Control

- A. Provide occupancy sensors, manual switches or integral photocells as indicated.

2.6 Outdoor Lighting Control Panel (LCT)

- A. Provide a photo control center with selector switches, pilot lights and mechanically held relays in accordance with Section 26 05 00 of these Specifications. When permitted by the selector switch, the photocontrol operates the control center to energize whenever natural lighting falls below 25 footcandles.
- B. Provide manual switching for each circuit to maintain lighting "ON" or "OFF" until manually returned to the "Automatic" position.
- C. Provide a photo-cell with the control center (shipped loose).
- D. Enclosure: NEMA 1.

Part 3 Execution

3.1 Installation

- A. Install lamps in luminaires and lampholders equipped with replaceable lamps.

- B. Install fixtures to center or replace acoustical tile sections. Support fixtures from the building structure through the use of the ceiling support system, where the ceiling support system is designed for the lighting fixture's weight. For lighting fixtures installed in exposed ceiling grid ceilings, provide two "safety clips" or "safety hooks" for securing fixture to ceiling grid, and located at opposite corners of fixture.
- C. Where "lay-in" lighting fixtures are installed in exposed grid ceilings provide a 14 gauge galvanized safety hanger wire which attaches the fixture to the building structural system to prevent the fixture from falling due to movements in ceiling suspension channels. Attach the safety wire to fixture at a point other than where safety clips are attached.
- D. Provide suspended fixtures with swivel hangers and threaded rod. For single-unit suspended linear fixtures, provide twin suspension hangers.
- E. Support surface lighting fixtures of more than 10 pounds in weight with threaded rods from the building structure.
- F. Attach wall-mounted fixtures to outlet boxes or directly to building or structure with stainless steel mounting hardware.
- G. Install plaster frames for lighting fixtures recessed in plastered ceilings.
- H. Mount continuous rows of linear luminaires in straight line. Utilize alignment clips between reflectors, where applicable.
- I. High Bay Luminaires: Use power hook hangers rated 500 pounds minimum or provide safety chain between housing and structure.

3.2 Relamping

- A. Relamp all non-LED luminaires at completion of work.

3.3 Adjusting and Cleaning

- A. Clean lenses and diffusers at completion of work. Clean paint splatters, dirt and debris from installed luminaires.
- B. Touch up luminaire and pole finish at completion of work.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Expansion Joints.
- B. Ductile Iron Couplings.
- C. Fabricated Steel Couplings.
- D. Isolation Joints.
- E. Flange Adapter Couplings.
- F. Equipment Connection Fittings.
- G. Dismantling Joints.

1.2 Related Sections

- A. Section 40 05 51 – Common Requirements for Process Valves.
- B. Section 40 05 97 – Identification for Process Equipment.
- C. Section 40 23 00 – Water and Wastewater Process Piping.

1.3 Submittals

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Provide data on materials, operational components, and accessories. Submit manufacturer's descriptive and technical literature for each component, including design recommendations; pressure and temperature ratings; dimensions; and chemical resistance to each chemical and chemical mixture in the gas and liquid stream.
- C. Operations and Maintenance Data: Submit under provisions of Section 01 78 23. Provide manuals for all operational devices.

Part 2 Products

2.1 Materials and Equipment

- A. Piping specialties, appurtenances, and equipment supplied as part of this contract shall be of equal material and ratings as the connecting pipe, new and unused except for testing equipment.

- B. Components that serve the same function and are the same size shall be identical products of the same manufacturer.
- C. Pipe fittings shall be compatible with the applicable pipe materials.
- D. Standard Products
 - 1. Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.
- E. All materials in contact with potable water shall be certified to NSF Standard 61 and shall comply with Federal lead-free requirements.

2.2 Expansion Joints

- A. Provide all structural work and equipment required to control expansion and contraction of piping. Verify that the anchors, guides, and expansion joints provided, adequately protect the piping systems.
- B. Wide Arch Elastomeric Connector:
 - 1. Flexible pump connectors/expansion joints shall be of the single or multiple wide arch type. Connectors' pressure rating shall be suitable for the application and shall have a minimum 4 to 1 safety factor, of burst pressure to rated pressure. Arch(s) to be open or filled as required for the application or per manufacturer's recommendation.
 - 2. Full-faced class 150 drilled rubber flanges shall be an integral part of the body. Joints shall include two-piece sleeved metal retaining rings for increased body and flange strength.
 - 3. Control units must be furnished in unanchored applications, or as recommended by the manufacturer.
 - 4. Bellows Arch Lining: Buna-N, or nitrile.
 - 5. Rated Deflection:

Size (inches)	Axial Compression (inches)	Lateral Deflection (inches)	Pressure (psig)
2 to 4	1.4	0.6	200
5 to 12	1.6	0.7	175
14 to 18	1.6	0.8	115
24 to 36	2.0	0.9	90

- 6. Manufacturers and Products:
 - a. Proco Products, Inc., Series 231.

b. Mercer, Flexmore Style 450.

c. Metraflex, Series 711.

C. Spherical Type Elastomer Connector:

1. Flexible pump connectors/expansion joints shall be of the molded spherical type.
2. Neoprene and nylon construction with internal steel wire, molded within the raised face ends, for added strength. Flanges shall be one-piece, free-floating, class 150 galvanized plate steel type with tapped or drilled holes as required.
3. Pressure rated for 225 psi at 240°F, with a minimum safety factor of 4 to 1.
4. Control units must be furnished in unanchored applications, or as recommended by the manufacturer.
5. Manufacturers and Products:
 - a. Metraflex Metrasphere.
 - b. Proco Products, Inc., Series 240.
 - c. Mercer, Masonflex.

D. Reducer - Spherical Type Elastomer Connector:

1. Flexible pump connectors/expansion joints shall be of the concentric, eccentric, reducing, molded spherical type.
2. EPDM and nylon construction with internal steel wire, molded within the raised face ends, for added strength. Flanges shall be one-piece, free-floating, class 150 galvanized plate steel type with a common centerline to both flanges.
3. Pressure rated for 225 psi at 240°F, with a minimum 4 to 1 safety factor.
4. Control rods or cables must be furnished in unanchored applications, or as recommended by the manufacturer.
5. Manufacturers and Products:
 - a. Metraflex Metrasphere Reducer.
 - b. Proco Products, Inc., Series RC/RE.
 - c. Mercer, FCR500/FER500.
6. Connectors shall be "Metrasphere Reducer" as manufactured by The Metraflex Company®, Chicago, IL.

E. Bolted Split Sleeve Expansion Joint for Metallic Pipe:

1. The expansion joint shall be a double slip type with 316 stainless steel wetted materials of construction and O-ring gaskets. Gaskets shall be EPDM for liquid service, silicone for air service.
2. The expansion joint shall be sized to match the associated piping. The maximum allowable working pressure shall be 150 psig.
3. Manufacturers and Products:
 - a. Equal to Victaulic Style 231S.

F. Expansion Joint for Non-Metallic Piping

1. The expansion joint shall be a reinforced molded wide arch bellows type.
2. End connections shall be ASME B16.1 Class 125 flanged, with split stainless steel retaining rings.
3. Required accessories for a complete assembly shall be provided including control rods.
4. Bellows Arch Lining: Buna-N, nitrile, or butyl.
5. Rated Temperature: 190 degrees F.
6. Rated Deflection and Pressure:
 - a. Lateral Deflection: $\frac{3}{4}$ inch, minimum.
 - b. Burst Pressure: Three times the working pressure.
 - c. Compression deflection and minimum working pressure as follows:

Size (inches)	Deflection (inches)	Pressure (psig)
1-1/2 to 8	1.5	210
10 to 12	2.25	210
14 to 20	2.25	150

7. Manufacturers and Products:
 - a. Proco Products, Inc., Series 261R.
 - b. Metraflex Series 711FRP.

2.3 Ductile Iron Couplings

- A. Ductile iron couplings for use in connecting of smooth end joints of cast iron, ductile iron, asbestos cement, steel, PVC or other types of pipe must be capable of fitting this variety of pipes with one set of follower flanges or end rings.

- B. Sleeve shall be of Ductile Iron ASTM A536. Ends shall have a smooth inside taper to provide uniform gasket seal. Sleeve shall be given a shop coat of oil-modified urethanes, corrosion-resistant paint, or epoxy coating.
- C. Follower flanges or end rings shall be of the thickness determined by the coupling size, and shall be ductile iron, ASTM-536. Flanges shall be identified by a color-coded shop coat finish.
- D. Gaskets shall be compression – type, formed with Virgin Styrene Butadiene Rubber (SBR,) ASTM D2000 3 BA715, and compounded with ingredients to produce permanence and resistance to set after installation. O.D. range shall be imprinted/molded on the gasket in permanent ink (Minimum).
- E. Bolts and Nuts shall be of high-strength, low-alloy steel, with nominal coarse thread, and hex nuts with black finish.
- F. Dimensions and minimum stress values shall be in accordance with AWWA/ANSI C111/A21.11.
- G. Manufacturers and Products:
 - 1. Smith-Blair, Inc. 441.
 - 2. JCM Industries 210.
 - 3. Romac Industries, Inc. 501.

2.4 Fabricated Steel Couplings

- A. Sleeve-Type Couplings, 1 inch through 24 inches
 - 1. Sleeve-type couplings shall be used for joining plain end pipe sections in a flexible manner with a diameter to properly fit the pipe. Coupling shall be suitable for pipe size and material, with stiffeners provided for HDPE pipe. Couplings shall comply with AWWA C219. Materials shall be as follows:
 - a. Sleeve: ASTM A53, ASTM A513 or Carbon Steel having minimum yield of 30,000 PSI.
 - b. Followers: Ductile Iron ASTM A536. Design for a high strength-to-weight ratio. Follower thickness determined by coupling size.
 - c. Bolts & Nuts: Stainless steel with heavy semi-finished hexagon nuts.
 - d. Gasket: Nitrile (Buna N) NSF 61 compounded to produce superior storage and performance characteristics while resisting water, acids, alkalies, most (aliphatic) hydrocarbon fluids, and other chemicals for a temperature range of -20°F to 180°F.
 - e. Finish: Fusion Bonded Epoxy Finish.
 - 2. Working Pressure: Up to 150 PSI

3. Manufacturers/Models

- a. Smith-Blair, Inc. 411.
- b. JCM Industries 201.
- c. Romac Industries, Inc. 400.

B. Transition Couplings:

- 1. Transitional couplings may be used to connect two pipes that have small differences in outside diameter. A fully assembled transitional coupling shall be sized to properly fit pipe diameters. Couplings shall comply with AWWA C219. Materials shall be as follows:
 - a. Sleeve: ASTM A53, ASTM A513 or Carbon Steel having minimum yield of 30,000 PSI.
 - b. Followers: Ductile Iron ASTM A536. Design for a high strength-to-weight ratio. Follower thickness determined by coupling size.
 - c. Bolts & Nuts: Stainless steel with heavy semi-finished hexagon nuts.
 - d. Gasket: Nitrile (Buna N) NSF 61 compounded to produce superior storage and performance characteristics while resisting water, acids, alkalies, most (aliphatic) hydrocarbon fluids, and other chemicals for a temperature range of -20°F to 180°F.
 - e. Finish: Fusion Bonded Epoxy Finish.
- 2. Working Pressure: Up to 150 PSI
- 3. Manufacturers/Models
 - a. Smith-Blair, Inc. 413.
 - b. JCM Industries 203.

2.5 Isolation Joints

- A. Dielectric Fittings: Dielectric fittings shall be provided between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure, temperature and corrosive application.
- B. Isolation Joints: Isolation joints shall be provided between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Isolation joints shall consist of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.6 Flange Coupling Adapters

- A. Flange coupling adapters shall be of the size and pressure rating required for each installation and shall be suitable for use on the pipe to be connected.
- B. All couplings shall have a sufficient number of factory-installed anchor devices to meet or exceed the test pressure rating for this project, or 300 psi minimum.
- C. Sleeve shall be of A36, A283 Gr. C, or Carbon Steel having a minimum yield of 30,000 PSI. Ends shall have a smooth inside taper to provide uniform gasket seal. Sleeve shall be given a shop coat of oil-modified urethanes, corrosion-resistant paint, or epoxy coating.
- D. Flanges shall be flat face flanges complying with AWWA C207 Class D, ANSI 150 lb. drilling.
- E. Gland shall be 65-45-12 Ductile Iron (ASTM A536) and shall be coated with the same material as the sleeve. MJ gaskets shall be standard SBR gaskets complying with AWWA C111 and ANSI A21. 11.
- F. Bolts and Nuts shall be of high-strength, low-alloy steel, per AWWA C111.
- G. Dimensions and minimum stress values shall be in accordance with AWWA/ANSI C111/A21.11.
- H. Manufacturers and Products:
 - 1. Smith Blair, Style 911.
 - 2. Romac Industries, Inc. RFCA.

2.7 Equipment Connection Fittings

- A. Equipment connection fittings shall provide both lateral and angular misalignment adjustment between equipment connection flanges and the connection to field piping systems by providing individually adjustable flexible joints at each connection. In addition, equipment connection fittings shall provide full pressure thrust restraint between the field piping connection and equipment connection flanges.
- B. Equipment connection fittings shall consist of two flanged coupling adapters, a plain end section of pipe and thrust restraint rods and associated fittings designed to transmit thrust without transmitting shear to the thrust restraint rods and without compromising provisions for accommodating angular and parallel misalignment. Materials and features shall conform to the requirements established in this paragraph. Standard "dismantling joints" incorporating only one flanged coupling adapter are not acceptable substitutes.
- C. Equipment connection fittings shall each consist of a single sleeve of plain end piping conforming to the requirements of the specified piping system of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with gasketed flange adapters at each end. Thrust restraint shall be provided

by means of all threaded rod spanning between flanges and male rod nuts and female washers that are rounded to provide a ball-joint type self-aligning feature. All threaded restraint rod shall project through flange and mating flange coupling adapter bolt holes or through holes in restraint lug plates that extend above the flanges and are secured to the flanges with a minimum of two flange bolts. Where the all threaded rods project through flange bolt holes, ball joint type nut and washer combinations and lock washers shall be provided at each face, each end. Where restraint lug plates are employed, ball joint type nuts and washers shall be provided only on the outside faces of the plates and the nuts shall have a self-locking feature that prevents nut movement due to vibration or other operational or environmental causes. Double nutting with non-locking nuts shall not be an acceptable method of providing the self-locking feature. Thrust rod diameter and material shall be selected to provide sufficient freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings to accommodate piping misalignment without transmitting any shear to the thrust rods and also to permit full development of thrust restraint at all thrust rod tension take-ups. Design of equipment connection fittings shall conform to AWWA C219.

- D. Thrust rods, restraint lug plates, nuts, washers and lock washers shall be Type 316 stainless steel, all selected to develop full rated piping system pressure thrust forces. Equipment connection fittings for pump applications shall have thrust rod number and diameter selected such that thrust rod stretch under piping system operating pressure does not exceed 2 mils. Calculations shall be submitted. Dry film molybdenum disulfide anti-galling compound shall be factory applied to ends of thrust rods, covering all threads subject to nut travel and tightening. Flange gaskets shall be full face type. Follower gaskets shall be compression wedge type.
- E. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61.
- F. Manufacturers and Products:
 - 1. Smith Blair, Style 914.
 - 2. Romac Industries, ECF Series.
 - 3. Baker Coupling Company.

2.8 Dismantling Joints (Restrained)

- A. Restrained dismantling joint fittings shall meet the specifications set forth in AWWA C219, be of the size and pressure rating required for each installation, and shall be suitable for use on the pipe to be connected. Restrained dismantling joint fittings shall have a sufficient number of factory-installed bolts and tie rods to meet or exceed the test pressure rating for this project, or 150 psi minimum.
- B. Followers for 3" thru 12" shall be Ductile Iron 65-45-12 per ASTM A536; for size 14" and larger shall be Carbon Steel C1020 per ASTM A576. Sleeve and spool weldment

material shall be Carbon Steel per ASTM A283C. Flanges shall meet AWWA C207 Class D Steel Ring Flange, compatible with ANSI Class 125 and 150 bolt circles. Total angular deflection up to 1-1/2° per joint. Bolts, nuts and tie rods shall be Type 304 stainless steel. Fittings shall have a fusion bonded epoxy finish which meets application methods AWWA C213.

- C. Gaskets shall be Nitrile (Buna-N) per ASTM D2000, NSF/ANSI 61 and 372 certified and compounded to resist water, oil, natural gas, acids, alkalies, most (aliphatic) hydrocarbon fluids, and many other chemicals. Temperature range: -20°F to +180°F.
- D. Manufacturers and Products:
 - 1. Smith Blair, Model 975.
 - 2. Romac Industries, Style DJ400.

2.9 Service Saddles

- A. Saddle casting or body for pipe up to sixteen inch nominal size shall be of the double strap/bale or double and single band type with minimum four studs/bolts on the single band type. Casting shall be cast bronze of the size and application specified. Material shall be in accordance with ASTM B62 and B584 (85-5-5-5) requirements and fabricated to ANCI/AWWAC800, latest revision. Saddles for PVC pipe shall be pre-formed to AWWA C900 and C905 outside diameter dimensions and so stamped or otherwise identified by a permanent inked marking that will not smear or wash off on the body of the saddle. C900 formed saddles may be used on ductile iron pipe from sizes four through sixteen inches.
- B. Saddle casting or body for ductile iron, cast iron and C900 pipe in sizes above sixteen inch (16") shall be ductile iron and shall be of the double or triple band stainless steel type of the size and application specified. Material shall be in accordance with ASTM A-536 requirements and fabricated to ANCI/ AWWA C800, latest revision. The saddle casting or body shall be coated with a fusion-bonded epoxy or high-density polyethylene. The body shall be NSF 61 approved. The coating shall be NSF 61 or U.L approved to the NSF 61 standard.
- C. Saddles for PVC water pipe shall conform to the design requirements of the Uni-Bell Handbook of PVC Pipe and AWWA Manual No. M23. The saddle shall provide full support around the circumference of the pipe. Provide a bearing area of sufficient width along the axis of the pipe, 2-inch minimum, ensuring that the pipe will not be distorted when the saddle is tightened.
- D. Polyvinyl chloride pipe (PVC) shall be furnished only with stainless steel band type straps. Bronze straps, bolts and nuts shall be silicon bronze conforming to ASTM B98, or waterworks bronze conforming to ASTM B584. Stainless steel bands, bolts and nuts shall conform to ASTM A240, type 304 (18-8). Straps of either the bale or band type shall be fabricated to the outside diameter pipe dimensions of the appropriate AWWA Specifications.

- E. The minimum width of double stainless steel bands for saddles to be installed on 12 inch or smaller water main pipe diameters shall measure one and one half inches each. The minimum width for single stainless steel bands shall measure three inches (3").
- F. The minimum width for double stainless steel bands on 16 inch and larger pipe diameters shall measure two inches each. The minimum width for single stainless steel bands shall measure four inches (4").
- G. The minimum gauge of the stainless steel bands shall be eighteen gauge. In order to prevent deformation, the minimum gauge of the stainless steel side bars shall be ten gauge. All welds shall be fully passivated for enhanced corrosion resistance.
- H. The bolts/studs shall be 5/8" UNC roll thread with heavy gauge flat hex nuts. All Stainless nuts shall be coated to prevent galling.
- I. Gaskets shall be virgin rubber, NSF 61 approved, meet ASTM D-2000 and be NBR or SBR compounded to produce permanence and resistance to set after installation and deterioration during storage.
- J. Quality control procedures shall be employed to ensure that the bronze saddle casting, straps (bronze bale or stainless steel band), and gasket are manufactured to be free of any visible defects. Each saddle shall have a working pressure rating not less than the following:

Pipe Size (inches)	Minimum Working Pressure Rating (psi)
12 and smaller	175
16 and larger	150

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.2 Preparation

- A. Protection: Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.
- B. System Preparation
 - 1. Provide accessibility to piping specialties for control and maintenance.

3.3 Manufacturer's Field Services

- A. Obtain manufacturer's technical assistance for Contractor training, installation inspection, start up, and owner operating and maintenance training.
- B. Follow manufacturer's instructions for installation.

3.4 Metallic Piping Couplings

- A. Thrust ties shall be provided where shown on the contract drawings and where required to restrain the force developed by 1.5 times the maximum allowable operating pressures specified. For metallic pipe other than ductile iron, thrust ties shall be attached with fabricated lugs. For ductile iron pipe, thrust ties shall be attached with socket clamps against a grooved joint coupling or flange. For exposed installations, zinc-plated nuts and bolts shall be used. However, high-strength, low-alloy steel, in accordance with AWWA C111/A21.11, may be substituted for use on cast iron and ductile iron couplings. For buried and submerged installations, TP304 stainless steel bolts and nuts shall be provided. Steel middle rings and followers shall be fusion bonded epoxy-lined and coated in accordance with Section 09 90 15 Paint and pressure tested beyond yield point.

3.5 Sleeve-Type Couplings

- A. Sleeve-type couplings shall be used for joining plain end pipe sections in a flexible manner with a diameter to properly fit the pipe.

3.6 Transition Couplings

- A. Transitional couplings may be used to connect two pipes of the same material that have small differences in outside diameter. A fully assembled transitional coupling shall be sized to properly fit pipe diameters.

END OF SECTION

Part 1 General

1.1 Work Included

- A. Furnish and install the following:
 - 1. Pipe Hangers.
 - 2. Pipe Supports.
 - 3. Concrete Inserts.
 - 4. Anchor Bolts.
 - 5. Cable Trays, Metallic and Non-Metallic.

1.2 Submittals

- A. Submit in accordance with Section 01 33 00.
- B. Product Data:
 - 1. Provide product data for each type of pipe hanger or support required.
 - 2. Submit manufacturer's data on cable tray including, but not limited to, types, materials, finishes, rung spacing, inside depths and fitting radii. For side rails and rungs, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).
- C. Shop Drawings:
 - 1. Indicate locations and mounting heights of each type of hardware.
 - 2. Submit manufacturer's templates and installation instructions.
 - 3. Submit drawings of cable tray and accessories including clamps, brackets, hanger rods, splice plate connectors, expansion joint assemblies, and fittings, showing accurately scaled components.

1.3 Quality Assurance

- A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Professional Engineer registered in the state where the Work is to be installed.
- B. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.

- C. All materials used in manufacturing hangers and supports shall be capable of meeting the respective ASTM standard specifications with regard to tests of physical and chemical properties and be in accordance with MSS SP-58.

1.4 Design Requirements

A. General:

1. Hangers and supports shall be of manufacturer's standard design and shall be adequate to maintain the supported load in proper position under all operating conditions. Meet requirements of MSS SP58 and ASME B31.1 or as modified by this Section.
2. Design, size and locate piping support systems throughout the facility, regardless of whether shown or not.
3. Supports are shown only where specific types and locations are required; additional pipe supports may be required.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes and internal pressures, including insulation and weight of fluid in pipes.
2. Wind loads in accordance with governing Codes and as shown on the Structural Drawings.
3. Maximum support spacing and minimum rod size: In accordance with MSS SP58, Table 3 and 4, excerpts of which follow below:

Nominal Pipe Size (inches)	Maximum Spacing (feet)
½ to 1-1/4	5
1-1/2	7.5
2	10
3-4	12
6-8	15
Over 8	20

- a. Ductile iron pipe 8 inches and smaller: Maximum span limited to that for standard weight steel pipe for water service with a minimum of one support per pipe section at the joints.
 - b. Ductile iron pipe 10 inches and larger: Maximum span limited to 20 feet with a minimum of one support per pipe section at the joints.
 - c. Supports for multiple plastic pipes shall be continuous wherever possible. Individually supported plastic pipes shall be supported as recommended by the manufacturer, except that the support spacing shall not exceed five (5) feet.
- 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 support systems to support new piping only in Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.
- F. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, the Contractor shall submit a certification stating that such requirements have been complied with.

1.5 Coordination

- A. Coordinate work under provisions of Section 01 33 00 and Section 01 61 00.
- B. Coordinate work with installation of process piping, piping insulation, and valves.

1.6 Delivery, Storage, and Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 66 00.
- B. Deliver items in their original factory shipping cartons.

Part 2 Products

2.1 General

- A. Verify that field measurements are as instructed by the manufacturer.
- B. Manufacturer: Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by Cooper B-Line, Inc. or engineer approved equal. Any reference to a specific figure number or a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Any item equal in type, style, quality, design and performance will be considered for approval.

2.2 Hangers

- A. Clevis: MSS SP58, Type 1:
 - 1. Cooper B-Line B3100 for steel pipe and B3102 for ductile iron pipe, ½-inch through 30 inches.
 - 2. Anvil Figure 260 with insulated saddle system (ISS) for insulated steel pipe, ½- inch through 16 inches for insulated steel pipe.

- B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP58, Type 6:
 - 1. Cooper B-Line Figure B3171, sizes ¾-inch through 8 inches.
 - 2. Anvil Figure 104, sizes ¾-inch through 8 inches.
- C. Steel Yoke Pipe Rolls and Roller Supports, MSS SP58, Type 41 or 43:
 - 1. Cooper B-Line Figure 3110 for sizes 2 inches through 24 inches, and Figure B3114 for 30 inches.
 - 2. Anvil Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
- D. Pipe Rollers and Supports, MSS SP58, Type 44:
 - 1. Cooper B-Line Figure 3120 for sizes 2 inches through 24 inches.
 - 2. Anvil Figure 175 for sizes 2 inches through 30 inches.

2.3 Wall Brackets, Supports and Guides

- A. Welded Steel Wall Brackets, MSS SP58, Type 33 (Heavy Duty):
 - 1. Cooper B-Line Figures B3065, B3066, and B3067 as required, for pipe sizes up to and including 20 inches. Additional wall bearing plates shall be provided where required.
- B. Adjustable "J" Hanger, MSS SP58, Type 5
 - 1. Cooper B-Line Figure B3690 for sizes ½ inch through 8 inches.
 - 2. Anvil Figure 67 for sizes ½ inch through 8 inches.
- C. Offset Pipe Clamp:
 - 1. Cooper B-Line B3148 for sizes ½" through 12 inches.

2.4 Pipe Saddles

- A. Saddle Supports, Pedestal Type:
 - 1. Minimum standard weight pipe stanchion, saddle, and anchoring flange. Pipe stanchion shall be galvanized or carbon steel, except that supports located in corrosive areas shall be 304 stainless steel.
 - 2. Non-adjustable saddle: MSS SP58, Type 37 with U-bolt:
 - a. Cooper B-Line Figure B3095 for sizes 1 inch through 36 inches with B3088S base.

3. Adjustable pipe saddle: MSS SP58, Type 38 without clamp:
 - a. Cooper B-Line Figure B3092 for sizes $\frac{3}{4}$ inch through 36 inches with B3088S base.

2.5 Channel Type Support Systems

- A. Channel Size: 12 gauge, 1-5/8 wide minimum steel, except that supports located in corrosive areas shall be 304 stainless steel or fiberglass.
- 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.

2.6 Pipe Clamps

- A. Riser Clamp: MSS SP58, Type 8
 1. Cooper B-Line Figure B3373 for sizes $\frac{1}{2}$ inch through 30 inches.
 2. Anvil Figure 261 for sizes $\frac{3}{4}$ inch through 24 inches.

2.7 Elbow and Flange Supports

- A. Elbow with Adjustable Stanchion:
 1. Anvil Figure 62C Base for sizes 2 inches through 18 inches.
- B. Elbow with Non-adjustable Stanchion:
 1. Anvil Figure 63A or 63B Base for sizes 2-1/2 inches through 42 inches.
- C. Flange Support with Adjustable Base:
 1. Standon Model S89, for sizes 2 inches through 24 inches.

2.8 Intermediate Pipe Guides

- A. Hold Down Pipe Guide:
 1. Cooper B-Line Figure B3552 for sizes 1-1/2 inches through 30 inches.
- B. U-Bolts, with double nuts to provide nominal 1/8 inch to $\frac{1}{4}$ inch clearance around pipe; MSS SP58, Type 24
 1. Cooper B-Line Figure B3188 and B3188NS.
 2. Anvil Figure 137 and 137S.

2.9 Pipe Alignment Guides

A. Spider Type

1. Cooper B-Line Figure B3281 to B3287 for sizes ½ inch through 24 inches.
2. Anvil Figure 255 for sizes ½ inch through 24 inches.

2.10 Pipe Anchors

A. Anchor Chair with U-bolt Strap

1. Cooper B-Line Figure B3147A or Figure B3147B.

2.11 Restraints

- ### A.
- Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.

2.12 Non-Metallic Cable Trays

- ### A.
- Non-metallic cable trays shall be used in all areas. Cable trays shall be as manufactured by Cooper B-Line, or equal.

B. Cable Tray Sections and Components

1. General: Except as otherwise indicated, provide non-metallic cable trays, of types, classes, and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features. Cable tray shall be installed according to the latest revision of NEMA VE-2.
2. Material and Finish: Straight section structural elements; side rails, rungs and splice plates shall be pultruded from glass fiber reinforced polyester or vinyl ester resin.
3. Pultruded shapes shall be constructed with a surface veil to insure a resin-rich surface and ultraviolet resistance.
4. Pultruded shapes shall meet ASTM E-84, Class 1 flame rating and self-extinguishing requirements of ASTM D-635.
5. All hangers and supporting materials shall be 304 stainless steel or non-metallic materials.

C. Type of Tray System

1. Ladder Cable Trays shall consist of two longitudinal members (side rails) with transverse members (rungs) mechanically fastened and adhesively bonded to

the side rails. Rungs shall be spaced 12 inches on center. Rung spacing in radiused fittings shall be industry standard 9" and measured at the center of the tray's width. Each rung must be capable of supporting a 200 lb. concentrated load at the center of the cable tray with a safety factor of 1.5.

2. Cable tray loading depth shall be 3 inches per NEMA FG-1.
3. Straight sections shall be supplied in standard 10foot lengths.
4. Cable tray inside widths shall be 24 inches or as shown on drawings. Outside width shall not exceed inside by more than a total of 2".
5. Straight and expansion splice plates will be of "L" shaped lay-in design with an eight-bolt pattern in 5" fill systems and four-bolt pattern in 3" and 2" fill systems. Splice plates shall be furnished with straight sections and fittings.
6. All fittings must have a minimum radius of 12 inches.
7. Molded fittings shall be formed with a minimum 3" tangent following the radius.
8. Systems with 3 inch loading depth shall have 90-degree and 45-degree molded fittings in 12 inch or 24 inch radius.
9. Dimension tolerances will be per NEMA FG-1.

D. Loading Capacities

1. Cable tray shall be capable of carrying a uniformly distributed load of 16 lbs./ft on a 10 foot support span with a safety factor of 1.5 when supported as a simple span and tested per NEMA VE 1 Section 5.2

2.13 Vibration Isolation and Supports

- A. For pneumatic, and other vibrating system applications, use a clamp that has a vibration dampening insert and a nylon inserted locknut. For copper and steel tubing use B-Line BVT series Vibraclamps, for pipe sizes use BVP series.
- B. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required.
- C. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.
- D. Vibration isolation products as manufactured by B-Line, Vibratrol systems.

2.14 Accessories

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, ½ inch minimum diameter, and as specified in Division 5.

2. Bolt Length (Extension above top of nut):
 - a. Minimum length: Flush with top of nut.
 - b. Maximum length: No more than a full nut depth above the top of nut.
- B. Dielectric Barriers:
 1. Plastic coated hangers, isolation cushion, or tape.
 2. Cooper B-Line Figure B1999 Vibra Cushion.
 3. Cooper B-Line Iso-Pipe or Iso-Tape.
- C. Insulation Shields, MSS SP58, Type 40
 1. Galvanized or stainless steel.
 2. Cooper B-Line Figure B3151 for sizes ½ inch through 24 inches.
- D. Welding Insulation Saddles, MSS SP58, Type 39
 1. Cooper B-Line Figure B3160 for sizes ½ inch through 24 inches.
- E. Hanger Rods: Hanger rods shall be machine threaded with load ratings conforming to ASTM Specifications and the strength of the rod based on rod diameter. Rods shall be 304 or 316 stainless steel in corrosive areas and galvanized in other areas. Hanger rods shall have the following minimum diameters:

Pipe Diameter (in.)	Rod Diameter (in.)
Less than 2-1/2	3/8
2-1/2 up to 4	½
4	5/8
6	¾
8 through 12	7/8
14 through 18	1
20 through 30	1-1/2
- F. Clevises, Nuts, Sockets and Turnbuckles: In accordance with MSS SP58.
- G. Attachments:
 1. Beam Clamps: Where applicable, beam clamps shall be used to suspend piping from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.
 - a. C-Clamps shall have locknuts and cup point set screws, B-Line B351L, or B3036L. Top flange c-clamps shall be used when attaching a hanger rod to the top flange of structural shapes, B-Line B3034 or B3033. Refer to manufacturer's recommendation for setscrew torque. Retaining straps shall be used to maintain the clamps position on the beam where required.

- b. Center loaded beam clamps shall be used where specified. Steel clamps shall be B-Line B3050, or B3055. Malleable iron or forged steel beam clamps with cross bolt shall be B-Line B3054 or B3291-B3297 Series as required to fit beams.
- 2. Concrete Insert: MSS SP58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
- 3. Welded Beam Attachment: MSS SP58, Type 22
 - a. Cooper B-Line Figure B3083.
- 4. Concrete Attachment Plates
 - a. Cooper B-Line Figures B3084, B3085 or B3086.

2.15 Finishes

A. Finishes

- 1. Hangers and strut shall be type 316 stainless steel with stainless steel hardware or non-metallic with non-metallic hardware.

Part 3 Execution

3.1 Inspection

- A. Verify that surfaces are ready to receive work and dimensions are as instructed by the manufacturer and required to provide proper support.
- B. Beginning of installation means acceptance of existing conditions.

3.2 Installation

A. General

- 1. All pipes, horizontal and vertical, shall be adequately supported from the building structure by pipe hanger and supports specified in Part 2 - Products. Install support systems in accordance with MSS SP58, unless shown otherwise.
- 2. Install pipe hanger rods plumb, within 4 degrees of vertical during startup, shutdown, or operations.
- 3. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings, and to minimize all pipe forces at pump housings. Pump housings shall not be utilized to support connecting pipes.

4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it or from metal stairs, ladders, or walkways unless it is so indicated on the Contract Drawings or specifically directed by the Engineer.
6. Supports shall be provided at changes in direction and elsewhere as shown on the Contract Drawings or specified herein.
7. Do not use adhesive anchors for attachment of supports to ceilings or walls.
8. Do not install pipe hangers or supports in equipment access areas or bridge crane runs.
9. Install hangers to provide a minimum of 1/2 inch space between finished covering and adjacent work.
10. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement during startup and shutdown.
11. Install lateral supports for lateral loads at changes in direction.
12. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
13. 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.

Grouped pipes: Trapeze hanger system. shall be supported by hangers suspended by stainless steel rods from stainless concrete inserts, beam clamps, or ceiling mounting bolts as follows:
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 3 inches and smaller.
 - c. Pipe hanger 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 inches of grout below baseplate.
 - b. Floor Mounted Channel Supports:
 - 1) Use for pipe smaller than three inches 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 inches of non-shrink grout and with anchor bolts.
 - 3) Attach pipe to channel with clips or pipe clamps.
 - c. Concrete Cradles:
 - 1) Use for pipe three inches and larger running along floors and in trenches at pipe elevations lower than can be accommodated using stanchion type.
4. Insulated piping:
 - a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
 - b. Provide pre-cut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system.
 - c. Wall-mounted pipe clips are not acceptable for insulated piping.
5. Vertical pipe:
 - a. Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments

1. Existing concrete ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
 - a. Single point attachment to ceiling is allowed only for 3/4 inch rod and smaller (8 inches and smaller pipe).
 - b. Where there are vibration or bending considerations, do not connect a single point support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

2. Steel beams: I-beam clamps or welded attachments.
3. Concrete walls: Concrete inserts or brackets or clip angles with concrete anchors.
4. Concrete beams: Concrete inserts, or if inserts are not used, attach to vertical surface similar to requirements for concrete walls. Do not drill into beam bottom.

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 diameters 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 non-stainless ferrous metal piping.
 - b. Install rubber wrap between submerged pipe and oversized clamps.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Wall Pipes.
- B. Floor Pipes.
- C. Pipe Sleeves.

1.2 Related Sections

- A. Section 40 05 97 – Identification for Process Equipment.
- B. Section 40 23 00 – Water and Wastewater Process Piping.

1.3 Submittals

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Provide data on materials, operational components, and accessories. Submit manufacturer's descriptive and technical literature for each component, including design recommendations; pressure and temperature ratings; dimensions; and chemical resistance to each chemical and chemical mixture in the liquid stream.
- C. Operations and Maintenance Data: Submit under provisions of Section 01 78 23. Provide manuals for all operational devices.

Part 2 Products

2.1 Materials and Equipment

- A. Piping specialties, appurtenances, and equipment supplied as part of this contract shall be of equal material and ratings as the connecting pipe, new and unused except for testing equipment.
- B. Components that serve the same function and are the same size shall be identical products of the same manufacturer.
- C. Pipe fittings shall be compatible with the applicable pipe materials.
- D. Standard Products
 - 1. Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that

essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

- E. All materials in contact with potable water shall be certified to NSF Standard 61 and shall comply with Federal lead-free requirements.

2.2 Flashing Sleeves

- A. Flashing Sleeves: Galvanized steel flashing sleeves shall be installed wherever piping passes through concrete roof structures. The flashing shall extend 8 inches from the pipe in all directions, extend up the pipe, and shall be fitted with double-threaded flashing for pipes 3 inches and smaller. Flashing shall turn down inside the pipe for 4 inch and larger pipes.

2.3 Wall Pipes and Floor Pipes

- A. Wall pipes and floor pipes shall be manufactured of ductile iron, grade 60-42-10, (minimum tensile strength: 60,000 psi; minimum yield strength: 42,000 psi; minimum elongation: 10%) in accordance with AWWA C151.
- B. Ends shall be as shown on the drawings. Where required, flanges and MJ bells can be tapped for studs.
- C. Wall pipe shall be fabricated of Special Class 53 thickness ductile iron pipe, unless otherwise noted.
- D. Wall pipe shall be furnished with one fabricated thrust/water stop collar design with 360° fillet welds on both sides of the collar.
- E. Unless otherwise noted, all cast-on flanges shall comply with AWWA C110 or C153, and all threaded-on flanges shall comply with AWWA C115.
- F. All mechanical joints shall comply with AWWA C111. Threaded-on or otherwise fabricated MJ bells shall be per applicable portions of AWWA C115 and C153.
- G. All wall pipes and floor pipes shall be provided with manufacturer's standard asphaltic coating.

2.4 Wall Sleeves

- A. Galvanized Steel Sleeves
 - 1. Provide galvanized steel sleeves for all pipes passing through concrete or masonry structures, or as shown on the Drawings. The sleeves shall be provided free of welding slag. Steel sleeve sizes through 10" shall be Schedule 40 Steel Pipe or standard wall thickness. Steel sleeve sizes 12" and larger shall have a .375" or standard wall thickness. Sleeves through wall shall be cast in place and the pipe shall be installed centered in sleeve. Provide minimum 2" x ¼" thick collar/water-stop of the same type of steel as the sleeve. The collar shall be welded all around on both sides to the sleeve at the point on the sleeve that

positions it at the mid-point of the structural wall when the sleeve is in place. The galvanized steel sleeve with water-stop shall be galvanized inside and outside.

2. Sleeves shall be Garlock Pipeline Technologies WSG, or equal.

B. Stainless Steel Sleeves

1. Provide stainless steel sleeves for all pipes passing through concrete or masonry structures, or as shown on the Drawings. The sleeves shall be provided free of welding slag. Stainless steel sleeve shall be fabricated of 304 stainless steel. Stainless steel sleeve sizes though 10" shall be Schedule 40S pipe or standard wall thickness. Stainless steel sleeve sizes 12" and larger shall have a .375" or standard wall thickness. Sleeves through wall shall be cast in place and the pipe shall be installed centered in sleeve. Provide minimum 2" x 1/4" thick collar/water-stop of the same type of steel as the sleeve. The collar shall be welded all around on both sides to the sleeve at the point on the sleeve that positions it at the mid-point of the structural wall when the sleeve is in place.

C. HDPE Sleeves

1. Where pipes must pass through walls and floors of new structures, unless otherwise shown or specified, install molded non-metallic high-density polyethylene sleeves. Sleeves shall have integrally formed hollow water stop sized having a minimum of four inches larger than the outside diameter of the sleeve itself and allowing 1/2" movement between wall forms to resist pour forces. Each sleeve assembly shall have end caps manufactured of the same material as the sleeve itself and installed at each end of the sleeve so as to prevent deformation during the initial concrete pour, and to facilitate attaching the sleeve to the wall forms. End caps will remain in place to protect the opening from residual debris and rodent entry prior to pipe insertion.
2. Sleeves shall be Garlock Pipeline Technologies Model CS CENTURY-LINE sleeves, or equal.

D. Wall Penetrations

1. Above Grade Wall Penetrations: Piping which passes through fire-rated or smoke-rated walls, floors, or ceilings shall be provided with insulated and encased pipe sleeves. Penetrations through an existing fire or fire barrier wall shall be sealed with a fire stop system that has an "F" rating not less than the required fire resistance rating of the penetrated wall. The fire stopping sealant for metal piping systems shall be a water-based vibration resistant, polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties, that is rated for 3 hours pursuant to ASTM E814 and UL requirements. The fire stopping sealant for plastic and insulated piping systems shall be a polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties, that is vibration and moisture resistant, and is rated for 3 hours pursuant to ASTM E814 and UL requirements with metal

collars. Vented plastic pipe penetrations shall be fitted with galvanized steel collars that have intumescent inlays.

E. Hydrostatic Seals

1. Potable Water Contact: Modular seals shall be Model "S61" LINK-SEAL® Modular Seal NSF 61 Certified for use in potable water, or equal. Bolts and nuts shall be 316 stainless steel. Seal element shall be made from Black NSF 61 certified EPDM materials, with Blue reinforced Nylon Polymer Pressure plates. Each shipment shall be packaged with a defining "NSF 61" label and batch number for traceability.
2. General Service: Modular seals shall be Model "C" LINK-SEAL® Modular Seal, or equal. Bolts and nuts shall be steel with 2-part Zinc Dichromate & proprietary corrosion inhibiting coating. Seal element shall be is made from Black EPDM materials, with reinforced Nylon Polymer Pressure plates.
3. Corrosive Duty/Wastewater: Modular seals shall be Model "S316" LINK-SEAL® Modular Seal, or equal. Bolts and nuts shall be 316 stainless steel. Seal element shall be is made from Black EPDM materials, with reinforced Nylon Polymer Pressure plates. Each shipment shall be packaged with a defining "NSF 61" label and batch number for traceability.
4. Petroleum Contact: Modular seals shall be Model "OS-316" LINK-SEAL® Modular Seal, or equal. Bolts and nuts shall be 316 stainless steel. Seal element shall be is made from green nitrile materials, with reinforced Nylon Polymer Pressure plates.
5. High Temperature Seal: Modular seals shall be Model "T" LINK-SEAL® Modular Seal, or equal. Bolts and nuts shall be steel with 2-part Zinc Dichromate & proprietary corrosion inhibiting coating. Seal element shall be is made from silicone materials, with pressure plates of steel with 2-part Zinc Dichromate & proprietary corrosion inhibiting coating.
6. Fire Seals: Modular seals shall be Model "FD and FS" LINK-SEAL® Modular Seal. Bolts and nuts shall be steel with 2-part Zinc Dichromate & proprietary corrosion inhibiting coating. Seal element shall be is made from silicone materials, with pressure plates of steel with 2-part Zinc Dichromate & proprietary corrosion inhibiting coating.

- F. Galvanizing: Galvanizing shall be hot-dip applied and meet the requirements of ASTM A153/A153M. Stainless steel components may be substituted where galvanizing is specified.

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.2 Preparation

- A. Protection: Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.
- B. System Preparation
 - 1. Provide accessibility to piping specialties for control and maintenance.

END OF SECTION

Ductile Iron Process Piping

Item	Description
General	A. Pipe fittings shall be compatible with the applicable pipe materials. B. Identification and Tagging: Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. C. All materials in contact with potable water shall be certified to NSF Standard 61 and Standard 372. D. Pipe supplier 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. E. 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. F. Pipe shall be handled during manufacture and shipped without nesting (i.e., insertion of one pipe inside another).
Pipe	A. Buried 1. Push-On Joint: AWWA C111/A21.11 and AWWA C151/A21.51, minimum pressure class 150. 2. Mechanical Joint: AWWA C111/A21.11 and AWWA C151/A21.51, minimum pressure class 250. Follower glands shall be ductile iron. 3. Restrained Joint: AWWA C111/A21.11 and AWWA C151/A21.51, minimum pressure class 250. Follower glands shall be ductile iron. B. Exposed/Aboveground 1. Grooved: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure. 2. Flanged: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining	A. Cement Mortar: Double cement lining conforming to AWWA C104/A21.4. B. Ceramic-epoxy: 1. Pipe and fittings to be ceramic epoxy lined shall not have been previously lined. 2. Surface preparation shall be made to surfaces free of grease, oil, or other substance with abrasive blasting using clean sand or grit abrasive. 3. Lining shall be done within 8 hours of surface preparation and surfaces shall be reblasted if rusting appears before lining. 4. Lining shall be applied only when temperatures are above 40 degrees F. 5. Line with an amine cured nonvalac epoxy containing at least 20 percent by volume of ceramic quartz pigment. The lining shall be 40 mils nominal

Ductile Iron Process Piping

	DFT. The lining shall be Protecto 401 Ceramic Epoxy, Thnemec Series 431 or equal. 6. Flange faces shall not be coated. 7. Lining thickness shall be tested using a magnetic film thickness gauge. Lining integrity shall be tested with a non-destructive, 2500-volt dielectric resistance test.
Coatings	A. Underground ductile iron piping shall be coated with the manufacturer's standard asphaltic coating, approximately 1 mil thick, applied to the outside of pipe and fittings. B. Above ground or exposed ductile iron piping shall be factory primed with a paint system compatible with the paint systems specified in Section 09 90 15.
Fittings	A. Lined and coated same as pipe. B. Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psig minimum working pressure. Follower glands shall be ductile iron. C. Restrained Joint: 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 mechanical joints, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Restrained joints relying on metal teeth molded into the gasket will be accepted as an alternate. D. Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure, Victaulic or equal. E. Flanged: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.
Joints	A. Mechanical: 250 psig minimum working pressure. B. Restrained Joint: 250 psi minimum working pressure. C. Grooved End: Rigid type radius cut conforming to AWWA C606. 250 psi minimum working pressure, Victaulic or equal. D. Flanged: Class 125 flat face. Ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. E. Branch Connections: Connections 3 inches and smaller shall be made with service saddles as specified in Section 40 05 06.
Couplings	A. Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536, Victaulic. B. Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536, Victaulic.

Bolting	A. Mechanical, Restrained, and Grooved End Joints: Manufacturer's standard. B. Flanged: ASTM A193/A193M Grade B8 Class 1 bolts and ASTM A194/A194M Grade 8 heavy hex head nuts shall be used. Bolts shall be provided with washers of the same material as the bolts. Use anti-seize coatings in assembly of nuts and bolts.
Gaskets	A. General: Gaskets in contact with potable water shall be NSF 61 certified. B. Mechanical and Restrained Joints - Water and Sewage Service: Rubber conforming to AWWA C111/A21.11. C. Mechanical and Restrained Joints – Air Service: EPDM or Viton and conforming to AWWA C111/A21.11. D. Grooved End Joints: EPDM conforming to ASTM D2000 and AWWA C606. E. Flanged – Liquid Service: Gaskets shall be 1/8 inch thick, vulcanized synthetic rubber, reclaimed rubber is not acceptable. F. Flanged – Air Service: Gaskets shall be 1/8 inch thick, EPDM, hardness 60 (Shore A), rated to 275 degrees F, conforming to ASME B16.21.
Joint Lubricant	A. Manufacturer's Standard

END OF SECTION

Stainless Steel Process Piping

Item	Size	Description
General		A. Pipe fittings shall be compatible with the applicable pipe materials. B. Identification and Tagging: Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. C. All materials in contact with potable water shall be certified to NSF Standard 61 and Standard 372. D. Pipe supplier shall submit certification that source manufacturing facility has been producing steel pipe of the specified diameters, dimensions, and standards for a period of not less than 10 years. E. Pipe shall be handled during manufacture and shipped without nesting (i.e., insertion of one pipe inside another). F. All grooved joint couplings, fittings, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
Pipe	2" and smaller	A. Threaded System: ASTM A312/A312M, seamless, Grade TP304L, pickled and passivated, Schedule 40S with dimensions conforming to ASME B36.19. B. Press System: ASTM A312, Type 304L, Schedule 10S, pipe dimensions conforming to ASME B36. 19M-1985.
	2-1/2" and larger	Manufactured from ASTM-A240 annealed and pickled sheets and plates in accordance with ASTM A778, Grade TP304L, with dimensions conforming to ASME B36.19. Grooved pipe ends shall be grooved in accordance with AWWA C-606 using Victaulic RX roll sets specifically designed for grooving Schd 10S stainless steel pipe. Pipe sizes 14" and up shall be supplied with Victaulic AGS groove profiles.
	2-1/2" to 6"	Schedule 10S
	8" to 12"	Schedule 5S

Stainless Steel Process Piping

Fittings	1-1/2" and smaller	Threaded Fittings: Forged, 1000 psi CWP, austenitic stainless steel, ASTM A182/A182M Grade TP304L, conforming to ASME B16.11, and threaded in accordance with ASME B1.20.1. Press Fittings: Victaulic Vic-Press ASTM A-312 stainless steel housings with ASTM A-276 and A-312 Outlets and austenitic type 304 stainless steel grooved ends with synthetic rubber Grade E EPDM gasket rated to 250 degrees F.
	2" and 2-1/2"	Welding Fittings: Butt-weld type, ASTM A403/A403M, material matching piping; annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long-radius elbows unless shown otherwise.
	3" and larger	Welding Fittings: Welding fittings shall be butt-weld type, material matching piping, ASTM A774/A774M, pickled and passivated; fitting wall thickness to match adjoining pipe; long-radius elbows unless shown otherwise.
Joints	2" and smaller	Threaded or flanged at valves and equipment, as required or shown.
	2-1/2" and larger	Butt-welded or flanged at valves and equipment.
Branch Connections	1-1/2" and smaller	Threaded straight or reducing tees in conformance with fittings specified above. For welded or grooved pipe, use threadolet.
	2" and larger	Butt-welding tee in conformance with fittings specified above.
Grooved Couplings	2" and larger	Grooved Couplings shall be manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Couplings shall be fusion-bonded epoxy coated, factory applied per AWWA C213, 12 mils minimum DFT and in accordance with NSF 61. Grooved couplings shall be provided in locations where vibration attenuation and/or thermal movement accommodation are required including branch connections and changes in direction. The grooved couplings indicated on the drawings are the minimum number of couplings required for thermal expansion and contraction at locations indicated. Grooved Couplings 12" and less in diameter shall be Victaulic Style 77. Grooved Couplings 14" and larger in diameter shall be Victaulic AGS Style W77.

Flanges	All	Forged stainless steel, ASTM A182/A182M, Grade F304L, ASME B16.5, slip-on or welding neck, faced and drilled to ASME B16.5 Class 150 with a 1/16 inch raised face. Weld-on slip-on flanges inside and out. Cast carbon steel: ASTM A216/A216M, Grade WCA, drilled, ASME B16.5 Class 150 Van Stone type with stainless steel stub ends, ASTM A240 Type 304L, conforming to MSS SP43, wall thickness same as pipe. Blind flanges, exposed to atmosphere and not immersed in liquid or buried, may be stainless steel, Class 125 ductile iron, or Class 150 carbon steel with gaskets as specified herein.
Unions	2" and smaller	Threaded forged: ASTM A182/A182M, Grade F316, 2000 or 3000 pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.
Bolting	All	Forged flanges and flanged joints in sumps, wet wells, submerged and wetted installations: ASTM A320, Grade B8M, Class 1 hex head bolts, ASTM A194/A194M Grade 8H hex nuts, and ASTM F436 washers at nuts and bolt heads. Achieve 40 to 60 percent of bolt minimum yield stress. Use anti-seize coatings in assembly of nuts and bolts. Van Stone Flanges and anywhere mating flange on equipment is cast iron and gasket is flat ring: Carbon steel A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 to 60 percent of bolt minimum yield stress. Grooved coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi.
Gaskets	All flanges	General: Gaskets in contact with potable water shall be NSF 61 certified. 1/8 inch thick EPDM, hardness No.60 (Shore A), rated 250 degrees continuous and conforming to ASME B16.21, and ASTM D1330, Steam Grade.

Thread Lubricant		Nickel-pigmented Polytetrafluoroethylene (PTFE) pipe-thread tape designed for stainless steel pipe.

END OF SECTION

Polyvinyl Chloride Process Piping

Item	Size	Description
General		A. Pipe fittings shall be compatible with the applicable pipe materials. B. Identification and Tagging: Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. C. All materials in contact with potable water shall be certified to NSF Standard 61 and Standard 372. D. PVC Pipe shall be colored, with the entire pipe being cast in a uniform color. The pipe colors shall be as follows: 1. Potable Water – Blue 2. Sewer – Green 3. Effluent Reuse – Purple 4. Other Liquids - White E. Pipe shall be handled during manufacture and shipped without nesting (i.e., insertion of one pipe inside another). F. Pipe shall be manufactured with titanium dioxide for UV protection.
Pipe	3" and smaller	Aboveground/Exposed: ASTM D1784, minimum cell classification 12454. Pipe shall be Schedule 80 conforming to D1785. Threaded nipples: Schedule 80 PVC. Underground: ASTM D1784, minimum cell classification 12454. Pipe shall be Schedule 80 conforming to ASTM D1785.
	4" and larger	Aboveground/Exposed: ASTM D1784, minimum cell classification 12454. Pipe shall be Schedule 80 conforming to D1785. Underground: PVC, ASTM D1784, minimum cell classification 12454. Pressure Class 235 (DR18) conforming to AWWA C900/C905 as applicable.]
Fittings	3" and smaller	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.
	4" and larger	Aboveground / Exposed : ASTM D2466 and ASTM D2467 Socket Type

Polyvinyl Chloride Process Piping

Joints	3" and smaller	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly shall be threaded or flanged.
	4" and larger	Aboveground / Exposed Joints shall be Solvent Weld Socket Type, except where connection to equipment may require future disassembly shall be flanged.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with fittings above. ASME B16.1, 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/F436M Type 3 washers at nuts and bolt heads. Achieve 40 to 60 percent of bolt minimum yield stress. Use anti-seize coatings in assembly of nuts and bolts. With raised face mating flange: Carbon steel A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 to 60 percent of bolt minimum yield stress.
Gaskets	All flanges	General: Gaskets in contact with potable water shall be NSF 61 certified. Flat face mating flange: Full-faced, 1/8 inch thick Ethylene Polypropylene (EPM) rubber. Raised face mating flange: Flat ring, 1/8 inch thick Ethylene Polypropylene (EPM) rubber, with filler gasket between OD of raised face and flange OD to protect flange from bolting moment.
Solvent Cement	All	Socket connections shall be joined with PVC solvent cement conforming to ASTM D2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Joints shall be prepared with primers conforming to ASTM F656 prior to cementing and assembly. Solvent weld cement for joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be

		suitable for the service. Certification shall be submitted. Solvent cement and primer shall be listed by NSF for use with potable water.
Thread Lubricant		Polytetrafluoroethylene (PTFE) pipe-thread tape.

END OF SECTION

Common Requirements for Process Valves**1.1 Related Sections**

- A. Section 09 90 15 - Paints.
- B. Section 40 05 61 – Gate Valves
- C. Section 40 05 62 - Plug Valves.
- D. Section 40 05 63 - Plastic Ball Valves.
- E. Section 40 05 78 - Air Valves for Water and Wastewater Service.

1.2 System Description

- A. This specification covers the requirements for above and below grade liquid process valves and accessories located both inside and outside of treatment plants.
- B. Performance Requirements
 - 1. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

1.3 Submittals

- A. Submit in accordance with Section 01 33 00.
- B. Shop Drawings:
 - 1. Product data sheets for each make and model of valve. Indicate valve Type number, applicable Tag number, and facility name/number or service where used.
 - 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
- C. Manufacturer's Certificate: Submit Manufacturer's Certificate of Compliance for:
 - 1. Valves used in Potable Water: Compliance with NSF 61 and Federal lead-free requirements.
- D. Operations and Maintenance Data: As specified in Section 01 78 23.
 - 1. Submit 6 copies each of operation and maintenance manuals in indexed booklet form. Detail in the Operation Manuals the step-by-step procedures required for specialized startup, operation and shutdown of piping systems, and include the manufacturer's name, model number, parts list and brief description of piping equipment such as valves and other appurtenances and their basic operating features.

2. List in the Maintenance Manuals routine maintenance procedures and troubleshooting guides for the equipment and include piping layout and valve locations.

1.4 Delivery, Storage, and Handling

- A. Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants.
- B. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, piping shall be capped to keep out dirt and other foreign matter.
- C. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Valves shall be handled and stored in accordance with the manufacturer's recommendation.

1.5 Maintenance

- A. Service: Services for systems shall be provided by a manufacturer's representative who is experienced in the installation, adjustment and operation of the equipment specified. The representative shall inspect the installation and supervise the adjustment and testing of the equipment.
- B. Extra Materials
 1. Submit the manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation. Concurrent with delivery and installation, spare parts for each different item of material and equipment specified that is recommended by the manufacturer to be replaced any time up to 1 year of service shall be furnished. For each type and size of valve, the following extra materials shall be provided: lubricator, lubricant (with appropriate temperature rating), lubricator/isolating valve; galvanized operating wrench, 4 feet long, for T-handled operators; galvanized operating key for cross handled valves. Extra materials shall include 2 of the following spare parts for each type and size of valve: gaskets; O-ring seals; elastomer parts; stem packing; seat rings and seat ring pulling tool.

Part 2 Products

2.1 Materials and Equipment

- A. Provide valves and appurtenances as specified and as shown on the drawings, and suitable for the service intended. Valves, appurtenances, and equipment supplied as part of this contract shall be of equal material and ratings as the connecting pipe, new and unused except for testing equipment.

- B. Components that serve the same function and are the same size shall be identical products of the same manufacturer.
- C. Identification and Tagging shall be per Section 40 05 97.

2.2 Valve Boxes and Service Boxes

- A. Valve and Service Boxes: The box length shall adapt to the length required for the depth of the line without full extension. Boxes shall be cast iron. The boxes shall have housings of sufficient size to completely cover the valve or service stop and shall be complete with covers.
- B. Valve Boxes: Valve boxes shall be cast iron two-piece screw type with drop covers. Valve boxes shall have a 5.25 inch inside diameter. Valve box covers shall weigh a minimum of 13 pounds. The valve boxes shall be adjustable to 6 inches up or down from the nominal required cover over the pipe. Valve boxes shall be of sufficient length that bottom flange of the lower belled portion of the box is below the valve operating nut. Ductile or cast iron extensions shall be provided as necessary. Covers shall have "WATER", "SEWER" or "REUSE", as appropriate, cast into them.
- C. Service Boxes: Service boxes shall be extension service boxes with either screw or slide-type adjustment.
- D. Extension Stems
 - 1. Extension stems shall connect to the valve with a wrench nut coupling and a set screw to secure the coupling to the valve's operating nut. The coupling and square wrench nut shall be welded to the extension stem. Extension stems shall be equal to Mueller A 26441 or M & H Valve Style 3801. Pipe couplings will not be acceptable.
 - 2. Extension stems for buried valves shall extend to within 12 inches of the surface of the ground. Connect each extension stem to the valve operator. Pin all connections. Each extension stem shall be provided with spacers that will center the stem in a valve box and shall be equipped with a standard AWWA wrench nut as described in Section 19 of AWWA C500, except when handwheels are indicated.

2.3 Valves

- A. General Requirements for Valves
 - 1. Valves shall include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation from the intended operating level.
 - 2. The valves shall be suitable for the intended service. Renewable parts are not to be of a lower quality than those specified.
 - 3. Valves shall be the same size as adjoining pipe, unless otherwise noted.

4. Valve ends shall be compatible with adjacent piping system.
 5. An operator shall be sized to operate the associated valve for the full range of pressures and velocities.
 6. Valves will open by turning counterclockwise.
 7. Operators, actuators, and accessories shall be factory mounted.
 8. All exterior nuts, bolts, fasteners, etc. shall be stainless steel or other non-corrosive material.
- B. Factory Finishing: Valves shall have an epoxy lining and coating in accordance with AWWA C550 unless otherwise specified. The epoxy shall be either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material shall apply if a valve coating is specified as "fusion" or "fusion bonded" epoxy. The epoxy lining and coating shall have a minimum 7.0 mils dry film thickness except where it is limited by valve operating tolerances. Exposed valves shall be finished in accordance with Section 09 90 15 – Paints. Safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be painted "safety yellow."

2.4 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 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90400 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. Comply with requirements of the Safe Drinking Water Act, including lead free requirements, and other applicable federal, state, and local requirements.
 2. Coatings materials to be formulated from materials deemed acceptable to NSF61.

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.2 Preparation

- A. Protection: Openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.
- B. System Preparation
 - 1. Backflow Preventers: Backflow preventers shall be installed with nameplate and test cocks accessible from front of unit, and with a minimum clearance of 12 inches between the port and grade. The assemblies shall be installed in accordance with local codes and shall discharge to an open drain with an air gap; vertical installation is prohibited.
- C. Valve Locations
 - 1. Valves shall be located in accordance with the contract drawings where actuators are shown. Where actuators are not shown, valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences.

3.3 Valve Installation

- A. Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.
- B. Valve Orientation
 - 1. The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations 4.5 feet or less above finished floor, unless otherwise shown on contract drawings. The operating stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations between 4.5 feet and 6.75 feet above finish floor, unless otherwise shown on contract drawings. Automatic valves shall be installed in accordance with the manufacturer's instructions and approved drawings.
 - 2. Butterfly Valves: Orientation of butterfly valves shall take into account changes in pipe direction. Valve shafts shall be oriented so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.
 - 3. Plug Valves: If a plug valve seat position is not shown in the contract drawings, locate the seat position as follows: for horizontal flow, the flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve; and for vertical flow, the seat shall be installed in the highest portion of the valve.
 - 4. Line Size Ball Valves: A line size ball valve and union shall be installed upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

- C. Isolation Valve: Safety isolation valves shall be installed on compressed air supplies. The valve shall be located to provide accessibility for control and maintenance. If necessary, access doors shall be installed in finished walls and plaster ceilings for valve access.
- D. Operator Extension Stems: Where the depth of the valve is such that its centerline is more than 3 feet below grade, an operator extension stem shall be furnished with a 2 inch operating nut to bring the operating nut to a point no more than 12 inches below the surface of the ground and/or box cover. The operating nut shall be located in a floor box.
- E. Torque Tube: Where the operator for quarter-turn valve is located on a floor stand, an extension stem torque tube shall be furnished, properly sized for the maximum torque capacity of the valve.
- F. Chain Wheel and Guide: Chain wheel and guide assemblies or chain lever assemblies shall be installed on manually operated valves located over 6.5 feet above finished floor elevation. Where chains hang in normally traveled areas, appropriate "L" type tie-back anchors shall be used.

3.4 Air Release, Drains and Sample Ports

- A. Sample ports shall be provided where indicated on the contract drawings. Install specified vents at piping high points for entrapped air release and install drains in the low points of pipelines regardless of whether shown on contract drawings.

3.5 Valve Testing

- A. Submit copies of all field test reports within 24 hours of the completion of the test.
- B. Valves may either be tested while testing pipelines, or as a separate step.
- C. Demonstrate that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications.
- D. Count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data.
- E. Air and vacuum relief valves shall be examined as the associated pipe is being filled to verify venting and seating is fully functional.
- F. Set, verify, and record set pressures for all relief and regulating valves. Self-contained automatic valves shall be tested at both maximum and minimum operating ranges and reset upon completion of test to the design value.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. This specification covers the requirements for manual actuators for above and below grade liquid process valves located both inside and outside of treatment plants.
- B. Valve manufacturer shall be responsible for mounting actuators on valves supplied under other sections and shall be responsible for coordinating the mounting of the actuators.

1.2 Related Sections

- A. Section 09 90 15 – Paints.
- B. Section 40 05 62 - Plug Valves.
- C. Section 40 05 63 - Ball Valves.

1.3 Submittals

- A. Submit in accordance with Section 01 33 00.
- B. Shop Drawings:
 - 1. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
- C. Operations and Maintenance Data: As specified in Section 01 78 23.
 - 1. Submit 6 copies each of operation and maintenance manuals in indexed booklet form. Detail in the Operation Manuals the step-by-step procedures required for specialized startup, operation and shutdown of piping systems, and include the manufacturer's name, model number, parts list and brief description of piping equipment such as valves and other appurtenances and their basic operating features.
 - 2. List in the Maintenance Manuals routine maintenance procedures and troubleshooting guides for the equipment.

Part 2 Products

2.1 Materials and Equipment

- A. Provide valve actuators as specified and suitable for the service intended.
- B. Components that serve the same function and are the same size shall be identical products of the same manufacturer.
- C. Standard Products

1. Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.2 Actuators

A. Manual Operators:

1. The force in a manual operator shall not exceed 40 pounds under any operating condition, including initial breakaway. The operator shall be equipped with gear reduction when force exceeds 40 pounds. The manual operator shall be a self-locking type or shall be equipped with a self-locking device. A position indicator shall be supplied on quarter-turn valves. Worm and gear operators shall be a one-piece design with worm-gears of gear bronze material. Worm shall be hardened alloy steel with the thread ground and polished. Traveling nut type operators shall have threaded steel reach rods with an internally threaded bronze or ductile iron nut.
2. Exposed Operators: Exposed operators shall have galvanized and painted handwheels. Lever operators are allowed on quarter-turn valves 8 inches and smaller. Cranks shall be supplied on gear type operators. If located off of the operator floor, chain wheel operator with tiebacks, extension stem, floor stands, and other accessories shall be provided to permit operation from normal operation level. Valve handles shall be capable of padlocking, and wheels shall be lockable with a chain and padlock.
3. Underground Operators: Buried service operators on valves larger than 2.5 inch shall have a 2 inch operating nut. Buried operators on valves 2 inches and smaller shall have a cross handle for operation by a forked key. The moving parts of valve and operator shall be enclosed in housing to prevent contact with the soil. Buried service operators for quarter-turn valves shall be designed to withstand an input torque of 450 foot-pounds of input torque at the fully open or fully closed positions, and shall be grease packed and gasketed to withstand a submersion in water to 10.0 psig. Buried valves shall have extension stems, bonnets, and valve boxes.

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.2 Preparation

- A. Protection: Openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Resilient-Seated Gate Valves.

1.2 Related Sections

- A. Section 09 90 15 – Paints.
- B. Section 40 05 51 - Common Requirements for Process Valves.
- C. Section 40 05 57 - Actuators for Process Valves.

Part 2 Products

2.1 Gate Valves - General

- A. General: AWWA Gate valves shall be in full compliance with stated AWWA standard and the following requirements:
 - 1. Provide 2-inch operating nut or 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-inch 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. Supply AWWA gate valves with stainless steel or other non-corrosive bolting and external fasteners.
 - 6. AWWA C509 and AWWA C515 valves may be substituted for each other.

2.2 Resilient Seated Gate Valves

- A. Gate Valves 2-½ inch and larger, Flanged
 - 1. Gate valves, 2.5 inch and larger, shall have cast-iron or ductile iron bodies with bronze trim. Valves shall meet the requirements of AWWA C509 and have Class 125 flanged end connections. Bonnet shall be a NRS Bolted type. Discs shall be wedge type of rubber coated ductile iron construction and have nonrising stems. Valves shall be equipped with handwheel operators.

2. Manufacturers and Products:
 - a. American Flow Control; Series 2500.
 - b. M&H Style 4067.
 - c. Mueller A2360.
- B. Gate Valves 2-½ inch and larger, MJ
 1. Gate valves, 2.5 inch and larger, shall have cast-iron or ductile iron bodies with bronze. Valves shall meet the requirements of AWWA C509 and have mechanical joint end connections. Bonnet shall be a NRS Bolted type. Discs shall be wedge type of rubber coated ductile iron construction and have non-rising stems. Valves shall be rated for 200 psig service. Valves shall be equipped with 2" operating nut, unless otherwise noted.
 2. Manufacturers and Products:
 - a. American Flow Control; Series 2500,
 - b. M&H Style 4067,
 - c. Mueller A2360.
- C. Thermoplastic Gate Valves, 1-½ inch and larger
 1. Thermoplastic gate valves, 1-½ inch and larger, shall have ASTM D1784 polyvinyl chloride (PVC) bodies, bolted bonnets, single polypropylene wedge discs, non-rising stems, and flanged end connections. Valves shall be rated for 150 psig service at 140 degrees F. Valves shall be equipped with handwheel operators.
 2. Manufacturers and Products:
 - a. Asahi/America Type P,
 - b. Or Equal.

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.2 Preparation

- A. Protection: Openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Eccentric Plug Valves for Liquid Service.

1.2 Related Sections

- A. Section 09 90 15 - Paints.
- B. Section 40 05 51 - Common Requirements for Process Valves.
- C. Section 40 05 57 - Actuators for Process Valves and Gates.

Part 2 Products

2.1 Eccentric Plug Valves for Liquid Service

- A. Eccentric Plug Valve, 2 Inches and smaller
 - 1. Nonlubricated type eccentric valves, 2 inch and smaller, shall be rated for 175 psig service at 140 degrees F. Valves shall have drip-tight shutoff with pressure from either direction, and cast iron bodies, ASME B16.11 threaded end connections, rubber lined plugs with round or rectangular ports, nickel seats, self-lubricating stainless steel stem bearings, and butadiene acrylonitrile stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber. Valves shall be equipped with lever operators, unless otherwise noted.
 - 2. Manufacturers and Products:
 - a. DeZurik, Style PEC,
 - b. Pratt, Ballcentric,
- B. Eccentric Plug Valve, 3-inch thru 12-inch
 - 1. Nonlubricated type eccentric valves, 3 inch thru 12 inch, shall be rated for 175 psig service at 140 degrees F. Valves shall have drip-tight shutoff with pressure from either direction, and cast iron bodies. Exposed service valves shall have flanged ends in accordance with ASME B16.1 flanged or AWWA C606 grooved end connections. Buried service valves shall have mechanical joint ends, unless otherwise noted.
 - 2. Plug shall be all metal, matching body with round or rectangular port with no less than 80% of connecting pipe area and coated with Buna-N, welded nickel seats, self-lubricating stainless steel stem bearings, and stem seal multiple V-rings or U-cups with O-rings of nitrile rubber, with grit seals on both upper and lower bearings. Valves to 6" shall be provided with lever operator (exposed) or operating nut (buried). Larger valves shall be equipped with totally enclosed,

geared, manual operator with handwheel or 2-inch nut. Size operator for 1.5 times the maximum shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.

3. Manufacturers and Products:

- a. DeZurik, Style PEC,
- b. Pratt, Ballcentric,

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Plastic Ball Valves.

1.2 Related Sections

- A. Section 09 90 15 - Paints.
- B. Section 40 05 51 - Common Requirements for Process Valves.
- C. Section 40 05 57 - Actuators for Process Valves and Gates.

Part 2 Products

2.1 Plastic Ball Valves

- A. PVC Ball Valve

1. Thermoplastic ball valves, 2 inch and smaller, shall be rated for 150 psig service at 120 degrees F, and have ASTM D1784, Type 1, Grade 1 polyvinyl chloride (PVC) bodies, balls, and stems. Valves shall be end entry, double union design, with solvent-weld socket ends connections, a fluoro-elastomer seat, and fluoro-elastomer or polytetrafluoroethylene (PTFE) O-ring stem seals. Valves shall have hand lever operators. Provide pressure relief hole drilled on low pressure side of ball.
2. Manufacturers and Products:
 - a. Nibco, Chemtrol Tru-Bloc,
 - b. Asahi/America, Type 21,
 - c. Spears, True Union,

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.2 Preparation

- A. Protection: Openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Air Release Valves for Water Service.
- B. Air Release Valves for Chemical Service.

1.2 Related Sections

- A. Section 09 90 15 - Paints.
- B. Section 40 05 51 - Common Requirements for Process Valves.

Part 2 Products

2.1 General

- A. Air Release and Vacuum Breakers
 - 1. Air release vents shall be located, and vented, such that a hazardous atmosphere will not be created upon operation.
 - 2. Locations: All pipeline high points shall have air release vents. Vacuum breakers shall be provided on all closed tanks and process equipment.

2.2 Air Release Valve for Water Service

- A. This specification covers automatic valves installed on water mains to vent accumulated air under system pressure, and to provide air exhaust during initial fill. The air release valve shall be in compliance with AWWA C512.
- B. Apco or Equal Cast Iron Air Release Valves through 2"
 - 1. Valves furnished under this specification shall conform to ANSI/NSF Standard 60 for direct additives and ANSI/NSF Standard 61 for indirect additives. Cast Iron Valve Body and cover shall be in accordance with ASTM A48-35 or ASTM A126 class B. Inlet sizes through 2 inches shall be screwed (NPT).
 - 2. Metallic Internal seat trim float arm and pivot pin shall be stainless steel type 303, 304 or 316. Metallic Floats shall be stainless steel ASTM A240. Other stainless steel metal internal parts shall be stainless steel ASTM A240 or ASTM A276.
 - 3. Valves requiring Internal seats or orifice buttons shall be Buna-N rubber compounded for water service. For valves requiring cover gaskets, the cover gasket shall be composition type, equal to Armstrong CS-231, Garlock 3000, or Lexide NK-511. If an O-Ring is used to seal the cover, it shall be on NSF 61 certified rubber. Cover bolts shall be alloy steel.

4. Valve body shall have a test pressure rating of 300 psi and working pressure rating of 150 psi. 1
5. The air release valve shall be designed to vent accumulated air automatically. The outlet orifice shall be properly sized to facilitate valve operation at pressures up to 150 psi. The air release valve shall be simple-lever or compound-lever depending upon volume requirements and the design of the valve.
6. Manufacturer/Model:
 - a. DeZurik/Apco 200A.
 - b. Crispin PL10.
 - c. GA Industries 920.

2.3 Air Release Valve for Chemical Service

- A. This specification covers automatic valves installed on chemical feed lines to vent accumulated air under system pressure, and to provide air exhaust during initial fill.
- B. PVC Air Release Valves through 2"
 1. The air release valve shall allow gases to escape from unpressurized pipe lines. As the unpressurized air vents, liquid rises to the float, which lifts the float up against the seat, holding liquid pressure. The float shall not release until the pressure on the inlet side of the valve is equal to the outlet pressure of the valve (normally atmospheric).
 2. Body and Float shall be PVC. Valves shall be of true union design, allowing servicing of the valve and internal components. Seals shall be EPDM or Viton, selected for compatibility with the chemicals to which the valve is exposed.
 3. Valve body shall have a working pressure rating of 150 psi.
 4. Manufacturer/Model:
 - a. Chemline Plastics Model AR.
 - b. Or Equal.

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.2 Preparation

- A. Protection: Openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

3.3 Valve Testing

- A. Submit copies of all field test reports within 24 hours of the completion of the test.
- B. Air and vacuum relief valves shall be examined as the associated pipe is being filled to verify venting and seating is fully functional.

END OF SECTION

Part 1 General

1.1 Work Required

- A. All piping, valves, fittings, conduit, panels, process equipment, accessories, etc., installed as part of this project shall be identified, color coded, stenciled or tagged as described herein or elsewhere in these Contract Documents and as required by OSHA, State and local safety codes.
- B. Exposed piping, valves, fittings, conduit, accessories, etc., shall conform to ANSI A13.1 color coding and identification system. Items shall be considered exposed unless buried or embedded in the construction. Insulated piping shall be color-coded as required for the carrier pipe.
- C. Buried or concealed equipment, devices, controls, piping, valves, fittings, conduit, accessories, etc., shall also be identified and provided with locating devices. Piping shall be identified in conformance with the color coding schedule.
- D. All valves shall be provided with identification tags.

1.2 Related Work Specified Elsewhere

- A. Section 09 90 15 - Paints.

1.3 Contractor Submittals

- A. Submittals shall be made in accordance with Section 01 33 00.
- B. The following submittals and specific information shall be provided:
 - 1. Samples of all types of identification devices to be used in the work.
 - 2. Technical product data and installation instructions for each identification material and device required.
- C. The Contractor shall submit to the Engineer, for approval, a list of suggested wording for all valve tags prior to fabrication. Upon approval, provide a complete list of all tagged valves (valve schedule) giving tag symbol (code and number), color, shape, location, use, type, size, pressure rating, and manufacturer's name.

1.4 Quality Assurance

- A. Manufacturers Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Part 2 Products

2.1 Identification of Exposed Piping

- A. All exposed piping and piping in accessible chases and areas above ceilings with panels, excluding stainless steel, shall be completely and totally painted for identification purposes as scheduled below.
- B. Each pipe identification shall consist of color coding in accordance with Paragraph 3.3 IDENTIFICATION SCHEDULE.
- C. For piping 8" in diameter and smaller, provide plastic pressure-sensitive adhesive labels or plastic clip-on type markers with legends and/or symbols as approved by the Owner. Arrows indicating direction of flow shall point away from legend. If flow may be both ways, use double-headed arrows. Background color shall be as recommended by ANSI A13.1 and approved by Owner. Markers for pipe and conduits shall be as follows:

Outside Diameter (Inches)	Minimum Letter Size (Inches)
¾ to 1-¼	½
1-½ to 2	¾
2-½ to 6	1-¼
8	1-½

- D. For piping larger than eight inches in diameter, the identification shall be by stenciling. Letters shall be black on piping that is painted light colors and white on piping that is painted dark colors. Letter and number sizes shall be ½ the diameter of the pipe up to a maximum letter or number size of 6 inches. Provide a painted label and a directional flow arrow. Where color bands are required, the painted label and directional arrow shall be placed between color bands. When more than one color band is used the different color bands shall be painted adjacent. Piping identification shall be located in accordance with Paragraph 3.2 PIPE IDENTIFICATION LOCATION.
- E. Color Bands and Arrows: Where color bands are required, color band size shall be as follows:
- | Pipe Size | Color Band Size |
|---------------------------|----------------------|
| less than 1" diameter | 1" wide |
| 1" to 12" diameter | 1 pipe diameter wide |
| greater than 12" diameter | 12" wide |

Second Band:

less than 1" diameter

 $\frac{1}{2}$ " wide

1" to 12" diameter

 $\frac{1}{2}$ pipe diameter

greater than 12" diameter

6" wide

- F. For cases where there are insulated lines wrapped with aluminum sheathing, stainless steel sheathing, or gray fabric, the background color shall be applied to a 24 inch length of pipe section and color band centered within the 24 inch field of background color.

- G. Paint Colors: Paint colors shall conform to the following designations:

Color	Federal Standard 595 Number
Light Blue	15200
Aqua	35275
Blue	15183
Dark Blue	15102
Red	21105
Yellow	13655
Orange	32473
White	17875
Light Brown (Tan)	30257
Dark Brown	20062
Light Green	34552
Olive Green	14087
Green	14062
Black	17038
Silver	17178
Grey	26152
Purple	17100
Purple – Reclaimed Water	Pantone 512C

2.2 Identification of Underground Pipe

- A. Underground metallic pipe and tube shall be located by laying 3-inch wide, minimum, plastic flagging tape continuously along the run of pipe or tubing. Tape shall be laid directly over the pipe and no closer than 12 inches to the top of pipe. The tape shall be a minimum of 4 mil inert polyethylene and be color-coded and stenciled as required for the item being identified.
- B. Underground non-metallic pipe and tube shall be located by laying 3-inch wide, minimum, plastic/metal impregnated flagging tape continuously along the run of pipe or tubing. Tape shall be laid directly over the pipe and no closer than 12 inches to

the top of pipe. The tape shall be a minimum of 4 mil inert polyethylene/aluminum foil composite and be color-coded and stenciled as required for the item being identified.

2.3 Identification of Valves

- A. Valves shall be marked in accordance with MSS SP-25 and shall bear an identification tag securely attached using stainless steel wire designed for that purpose. Identification tags shall be 1.375 inch minimum diameter, made of stamped stainless steel. Indentations shall be black for reading clarity.
- B. The size, valve type, service, and valve identification number as shown on the Valve Schedule in the contract drawings shall be displayed.
- C. Valve tags for underground valves shall be permanently affixed to the concrete pad surrounding the valve box.

2.4 Existing Identification Systems

- A. In installations where existing piping identification systems have been established, the Contractor shall continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves and appurtenances to the level specified herein.

2.5 Identification of Pipe 5/8 Inch or Smaller

- A. Where the outside diameter of pipe or pipe covering is 5/8 inch or smaller, metal tags shall be provided instead of lettering. Tags shall have the specified identifying lettering stamped in the tag and shall be fastened to the pipe with suitable chains. Metal tags and chains shall be aluminum or stainless steel. Where tags are used, pipe shall be color coded as specified in Paragraph 3.3.

Part 3 Execution

3.1 General

- A. All labels and identification tags shall be installed in accordance with the manufacturer's printed instructions and shall be neat and uniform in appearance. All such tags or labels shall be readily visible from all normal working locations.

3.2 Pipe Identification Location

- A. Straight lines of pipe shall be identified at intervals of 20 feet maximum, and at least once in each room unless otherwise directed by the Engineer.

- B. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches and on both sides of each floor, wall or barrier through which the line passes.
- C. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

3.3 Identification Schedule

- A. Application of identifying devices shall conform to the following color codes, or match existing color code as directed by the Engineer.

MATERIAL IN PIPE	BACKGROUND COLOR/BAND COLOR(S)
Potable Water	Dark Blue
Non-potable Water	Blue/Black
Sludge	Dark Brown/Black
Compressed Air (non-instrument)	Light Green
Instrument Air	Light Green/Dark Green
Process Air	Dark Green
Equipment Vent	same as equipment
Sample Line	same as line or equipment being sampled
Plant Drain	Dark Gray
Storm Drain	Black

END OF SECTION

Water and Wastewater Process Piping

Part 1 General

1.1 Section Includes

- A. This specification covers the requirements for above and below grade water and wastewater process piping located within the facility.

1.2 Related Sections

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 09 90 15 - Paints.
- C. Section 40 05 06 - Couplings, Adapters, and Specials for Process Piping.
- D. Section 40 05 07 - Pipe Hangers and Supports.
- E. Section 40 05 09 - Wall Pipes, Floor Pipes, and Pipe Sleeves.
- F. Section 40 05 97 - Identification for Process Equipment.
- G. Section 40 42 00 - Process Piping and Equipment Insulation.
- H. Section 40 80 01 - Process Piping Leakage Testing.

1.3 Definitions

- A. Submerged or Wetted: The zone below:
 - 1. Top face of channel walls and top slabs.
 - 2. Two feet above the maximum liquid surface.
 - 3. Top of tank wall or under tank cover.

1.4 System Description

- A. Design Requirements: Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:
 - 1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
 - 2. Building Service Piping: ASME B31.9, as applicable.
 - 3. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code and local plumbing code.

4. Buried Piping: Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.
 5. Above Grade Piping Systems: Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.
- B. Performance Requirements: The pressure ratings and materials specified represent minimum acceptable standards for piping systems. The piping systems shall be suitable for the services specified and intended. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

1.5 Submittals

- A. The following shall be submitted in accordance with Section 01 33 00.
- B. Shop Drawings:
1. Submit manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; thermal characteristics (coefficient of expansion and thermal conductivity); and chemical resistance to each chemical and chemical mixture in the liquid stream.
 2. Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials.
- C. Certifications:
1. Provide manufacturer's certification of compliance with AWWA C111 for all mechanical joint bolts with each shipment.
- D. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, the P&IDs found in the contract drawings shall be revised to reflect the constructed process system.
- E. Special Tools: A list of any special tools necessary for each piping system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system.

1.6 Qualifications

- A. Contractor: Submit a statement certifying that the Contractor has the specified experience. Contractor shall have successfully completed at least 3 projects of the same scope and size or larger within the last 6 years. Contractor shall demonstrate specific experience in regard to the system installation to be performed.
- B. Welders: Submit the names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc. The welding of pressure piping systems shall be in accordance with qualifying procedures using performance qualified welders and operators. Structural members shall be welded in accordance with Section 05 50 00 - Miscellaneous Metals.

1.7 Delivery, Storage, and Handling

- A. Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants.
- B. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense.
- C. During installation, piping shall be capped to keep out dirt and other foreign matter.
- D. A material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F402. Storage facilities shall be classified and marked in accordance with NFPA 704. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage.
- E. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe shall be packed, packaged and marked in accordance with ASTM D3892.

1.8 Project/Site Conditions

- A. Existing Conditions
 - 1. Verify existing piping and penetrations. Prior to ordering materials, expose all existing pipes which are to be connected to new pipelines. Verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes, and inspect size and location of structure penetrations to verify adequacy of wall sleeves, and other openings before installing connecting pipes.

1.9 Sequencing and Scheduling

- A. For slab, floor, wall, and roof penetrations, keep on site pertinent wall pipes and sleeves before they are required for placement in concrete forms. Verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

Part 2 Products

2.1 Materials and Equipment

- A. Provide piping materials and appurtenances as specified and as shown on the drawings, and suitable for the service intended.
- B. Piping materials, appurtenances, and equipment supplied as part of this contract shall be of equal material and ratings as the connecting pipe, new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the piping systems are indicated by service in the Pipe Schedule included in this specification. Submit a list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the contract drawings.
- C. Pipe fittings shall be compatible with the applicable pipe materials.
- D. Standard Products: Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Nominal sizes for standardized products shall be used.
- E. Identification and Tagging: Each piece of pipe shall bear the ASTM designation and all other markings required for that designation.
- F. All materials in contact with potable water shall be certified to NSF Standard 61 and Standard 372.

2.2 Drains

- A. Valved drains may not be shown on the detailed drawings for individual pipelines; their absence will not relieve the Contractor of the responsibility for providing and installing them as indicated in the piping and instrumentation diagrams to complete the piping system for the use intended.
- B. Locations: All pipeline low points shall be drained.
- C. Sizes: For pipelines 2.5 inch and larger, drains shall be 0.75 inch and equipped with ball valves. For pipelines 2 inch and smaller, drains shall be 1/2 inch and equipped with ball valves.

Part 3 Execution

3.1 Examination

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.2 Preparation

- A. Protection: Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.
- B. System Preparation
 - 1. Pipe and Fittings: Pipe and fittings shall be inspected before exposed piping is installed or buried piping is lowered into the trench. Clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.
 - 2. Damaged Coatings: Repair damaged coating areas in the field with material equal to the original coating. Do not install damaged piping materials. Field repair of damaged and uncoated areas of galvanized piping shall conform to ASTM A780/A780M.
 - 3. Field Fabrication: Notify the Engineer at least 2 weeks prior to the field fabrication of pipe or fittings and at least 3 days prior to the start of any surface preparation or coating application work.
- C. Field welding shall be performed in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, and as recommended by piping or fitting manufacturer. Welding electrodes shall be provided in accordance with Table 3.1 of AWS D1.1/D1.1M as required for the applicable base metals and welding process. Fabrication of fittings shall be performed in accordance with the manufacturer's instructions.

3.3 Exposed Piping Installation

- A. Exposed piping shall be run as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Piping and appurtenances shall be installed in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3. Piping shall be installed without springing or forcing the pipe.
- B. Anchors and Fasteners: Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

1. Drilled-In Expansion Anchors and Fasteners:
 - a. Anchors in brick or block shall be designed to accept both machine bolts and/or threaded rods. Such anchors shall consist of an expansion shield and expander nut contained inside the shield. The expander nut shall be fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches, and bears against the shield bottom. The shield body shall consist of four legs, the inside of each shall be tapered toward shield bottom (or nut end). The end of one leg shall be elongated and turned across shield bottom. The outer surface of shield body shall be ribbed for grip-action. The expander nut shall be of square design with sides tapered inward from bottom to top. The anchor materials of construction shall be TP304 stainless steel of 43,541 psi minimum tensile strength. Fasteners shall be machine bolts for use with above anchors; nuts and washers shall conform to ASTM A194/A194M. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.
 - b. The anchor/fastener assembly for solid concrete shall be UL listed with a one-piece stud (bolt) that has integral expansion wedges, nuts and washers. The stud shall be constructed of TP304 stainless steel, and nut and washer of TP304 stainless steel. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.
 2. Drilled-In Adhesive Anchors: Drilled-in adhesive anchors shall not be used for overhead applications. The anchors shall be composed of an anchor rod assembly and an anchor rod adhesive cartridge. The anchor rod assembly shall be a chamfered and threaded stud rod of TP304 stainless steel with a nut and washer of TP316 stainless steel. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application. The adhesive cartridge shall be a sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial within the capsule. The capsule ingredients shall be activated by the insertion procedure of the anchor rod assembly.
- C. Piping Expansion and Contraction Provisions: The piping shall be installed to allow for thermal expansion and contraction resulting from the difference between installation and operating temperatures. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial shall have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI TR-21. Anchors shall be installed as shown in the contract drawings to withstand expansion thrust loads and to direct and control thermal expansion. An intermediate pipe guide shall be installed for every pipe at each metal channel framing support not carrying an anchor or alignment guide. Where pipe expansion joints are required, pipe alignment guides shall be installed adjacent to the expansion device and within four pipe diameters. Expansion devices shall be installed in accordance with the manufacturer's instructions and at the locations shown in the contract drawings.

- D. Piping Flexibility Provisions: Thrust protection shall be provided as required. Flexible couplings and expansion joints shall be installed at connections to equipment, and where shown on the contract drawings. Additional pipe anchors and flexible couplings beyond those shown on the contract drawings, shall be provided to facilitate piping installation, in accordance with reviewed shop drawings.
- E. Couplings, Adapters and Service Saddles: Pipes shall be thoroughly cleaned of oil, scale, rust, and dirt in order to provide a clean seat for gaskets. Gaskets shall be wiped clean prior to installation. Flexible couplings and flanged coupling adapter gaskets shall be lubricated with the manufacturer's standard lubricant before installation on the pipe ends. Couplings, service saddles, and anchor studs shall be installed in accordance with manufacturer's instructions. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Torque-limiting wrenches shall be used to tighten bolts.
- F. Piping Equipment/Component Installation: Piping components and indicators shall be installed in accordance with manufacturer's instructions. Required upstream and downstream clearances, isolation valves, and miscellaneous devices shall be provided for an operable installation. Provide union or flange at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal. Straight runs of piping upstream and downstream of flow measuring devices shall be as shown in the contract drawings.
- G. Pipe Tap Connections: Taps to pipe barrels are unacceptable. Taps to ductile iron piping shall be made only with a service saddle or at a tapping boss of a fitting, valve body, or equipment casting. Taps to steel piping shall be made only with a welded threadolet connection.
- H. Plastic Pipe Installation
 - 1. Submit a statement signed by the plastic pipe manufacturer's representative certifying that the Contractor's personnel are capable of properly installing the piping system on the project. All plastic pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations.
 - 2. Heat joining shall be performed in accordance with ASTM D2657. Electrofusion joining shall be performed in accordance with ASTM F1290. Schedule 40 pipe shall not be threaded. Schedule 80 threaded nipples shall be used where necessary to connect to threaded valves or fittings. Strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to over tighten these fittings.
 - 3. Pipe shall not be laid when the temperature is below 40 degrees F, nor above 90 degrees F when exposed to direct sunlight. Any plastic pipe installed above grade and outdoors shall be ultraviolet (UV) protected or UV resistant.
 - 4. The pipe ends that are to be joined shall be shielded from direct sunlight prior to and during the laying operation. Adequate ventilation shall be provided when working with pipe joint solvent cement and the handling of solvent cements, primers and cleaners shall be in accordance with ASTM F402.

5. PVC Piping: Solvent-cemented joints shall be constructed in accordance with ASTM D2855.
6. FRP Piping: Pipe, duct, and fittings shall be cut, fabricated, and installed in strict accordance with the pipe manufacturer's written recommendations and as shown on the contract drawings. All FRP pipe and fittings shall have interior surfaces which are highly polished, with no exposed fibers. Field joints shall be cured as recommended by the manufacturer.
- I. Insulation: Insulation shall be installed on piping as indicated in the contract drawings in accordance with the provisions of Section 40 42 00 - Process Piping and Equipment Insulation.
- J. Piping Clearance, unless otherwise shown:
 1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system, including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 3. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
 5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
 6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
 7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.4 Buried Pipe Placement

- A. Thermoplastic piping systems shall be installed underground in accordance with ASTM D2774.
- B. Fittings
 1. At valves and connections, the trench bottom shall be dug out with sufficient length, width, and depth to ensure clearance between the undisturbed trench bottom and the valves and such connections.

- C. Thrust Restraint: Thrust restraint devices are generally not shown in the contract drawings; their absence will not relieve Contractor of the responsibility for providing them as required to provide complete systems for the use intended. Provide thrust blocks and ties where required, whether or not shown on the contract drawings. At a minimum, thrust restraint shall be provided at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.
 - 1. Thrust Blocks: Thrust blocking shall be concrete of a mix not leaner than 1 cement, 2.5 sand and 5 gravel, and have a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust blocks shall be poured against undisturbed earth. The sides of thrust blocks not subject to thrusts may be poured against forms. The area of bearing shall be as shown or directed. Blocking shall be placed so that fitting joints shall be accessible for repair. Steel rods and clamps, protected by galvanizing or a coating of bituminous paint shall be used to anchor vertical down bends into gravity thrust blocks.
 - 2. Restrained Joints: The restrained pipe length shall be as shown in the table on the drawings. Where restraint for particular fittings or conditions is not specified, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA TRD.
- D. Marking Tape: Pipe marking tape shall be provided and installed in accordance with the requirements of Section 40 05 97 – Identification for Process Equipment.
- E. Plastic Pipe Installation
 - 1. Plastic pipe shall be cut, fabricated, and installed in strict conformance with the pipe manufacturer's recommendations. Offset loops from the trench centerline shall be as recommended by the manufacturer for the maximum temperature variation between the pipe temperature at the time of solvent welding and operating temperature. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial shall have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI TR-21. Flexible plastic pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between the plastic pipe at the flanged joint and the rigid structures is possible. Thrust blocking shall not be used for flexible plastic piping. The piping shall be designed and installed to withstand the compression and expansion forces imposed by the trench conditions.

3.5 Connecting Dissimilar Pipe

- A. Flexible transition couplings, dielectric fittings and isolation joints shall be installed in accordance with the manufacturer's instructions.

3.6 External Corrosion Protection

- A. Protect all pipe and piping accessories from corrosion and adverse environmental conditions.
- B. Underground Metallic Piping: Buried metallic piping shall be protected from corrosion using protective coatings
- C. Above Grade Metallic Piping:
 - 1. Nonferrous and stainless steel piping shall not be painted. Where dissimilar metals are joined, isolation joints shall be used.
 - 2. Ferrous Piping: Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, mill scale or other foreign substances shall be mechanically cleaned by commercial sand blasting conforming to SSPC SP 6/NACE No.3 and primed in accordance with Section 09 90 15. Primed surfaces shall be finished in accordance with Section 09 90 15.

3.7 Flexible Joints at Concrete Structures

- A. Flexible joints shall be provided at the face of all structures, whether or not shown on the contract drawings. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints shall be considered flexible joints; welded pipe joints shall not. Joints may be flush with the structure face or may be located up to 1 pipe diameter away from face, but not further than 18 inches away from face.

3.8 Closures

- A. Closure pieces shall be installed as necessary to end pipe runs and shall conform to ASME B16.9 or ASME B16.11. Elastomer sleeves bonded to pipe ends are not acceptable. Pressure piping shall have closures of blind flanges unless otherwise shown on contract drawings or approved by the Engineer. Pipes with restrained joints shall have pipe closures installed with thrust tie-rod assemblies

3.9 Penetrations

- A. Steel pipe sleeves shall be hot-dipped galvanized after fabrication for above grade applications in non-submerged areas. For below grade, or in submerged and damp environments, steel pipe sleeves shall be lined and coated as specified in Section 09 90 15 - Paints. Embedded metallic piping shall be isolated from concrete reinforcement using coated pipe penetrations. Coatings shall be as specified in Section 09 90 15 - Paints. Wall pipes shall be securely supported by form work to prevent contact with reinforcing steel and tie-wires. Joints shall be sealed with a wall penetration seal. For existing concrete walls, rotary drilled holes may be provided in lieu of sleeves.

3.10 Pipe Identification, Painting and Color Coding

- A. Color, coating, and lettering requirements for exposed piping shall be in accordance with Section 40 05 97 – Identification for Process Equipment.

3.11 Field Quality Control

- A. Hydrostatic Tests: Where any section of a pipeline is provided with concrete thrust blocking for fitting, the hydrostatic tests shall not be made until at least 5 days after the installation of the concrete thrust blocking, unless otherwise approved by the Engineer.
- B. Buried Piping: After the pipe is laid, the joints completed and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic test pressure as listed in the Pipe Schedule. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced as necessary. Defective pipe, joints, fittings, and valves found during the pressure test shall be removed and replaced with new material, and the test repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Engineer when one or more of the following conditions are encountered: (1) wet or unstable soil conditions in the trench; (2) compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions; or (3) maintaining the trench in an open condition would delay completion of the Contract. The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the hydrostatic tests.
- C. Exposed Piping:
 - 1. Hydrostatic testing shall be conducted in accordance with ASME B31.3. Piping systems shall be tested under normal service conditions as indicated in the Pipe Schedule to demonstrate compliance. The test pressure shall not be less than 1.5 times the design pressure. Water shall be used as the hydrostatic test fluid. Provide clean test water of such quality to prevent corrosion of the piping system materials. Air release vents shall be opened at all high points of the piping system in order to purge air pockets while the piping system is filling.
 - 2. For rigid piping hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3 but shall not exceed the yield strength of the piping system. The maximum velocity during filling shall be 0.25 fps applied over full area of pipe.

3. Test all parts of the piping system. The hydrostatic test pressure shall be maintained continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage. All joints and connections shall be examined for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking. Correct visible leakage and retest. Unless otherwise directed by the Engineer, the piping system shall be left full of water after leaks are repaired.
 4. For non-rigid, non-metallic piping hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3 but shall not exceed 1.5 times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling shall be 0.25 fps applied over full area of pipe. The system shall be initially pressurized to 50 percent of the normal service conditions and inspected. Any leaks shall be repaired by the Contractor. The system shall then be pressurized to the test pressure. Small amounts of water shall be added as required on an hourly basis for a maximum of 3 hours in order to maintain the test pressure. After 4 hours, the test pressure shall be lowered by 10 psi. If the hydrostatic pressure remains steady for 1 hour, then no leakage is indicated. Inspect for leaks, repair and retest if necessary. The piping system shall be allowed to relax for 8 hours before retesting.
- D. Time for Making Test: Except for joint material setting or where concrete thrust blocks necessitate a delay, underground piping jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Tests for above ground pressure piping shall be conducted after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.
- E. Pipe Leakage Tests
1. Unless approved by the Engineer, leakage testing shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the piping shall be subjected to not less than 200 psig. Leakage is defined as the quantity of water that is supplied to the piping system, or any valved or approved section thereof, in order to maintain pressure within 5 psi of the specified leakage test pressure after the piping has been filled with the test liquid and all air is expelled. No piping installation will be accepted if leakage exceeds the allowable leakage determined by the following formula:
$$L = C_f \times N \times D \times P^{0.5}$$

C_f = conversion factor = 0.0001351
 L = allowable leakage, gallons per hour
 N = number of joints in the length of piping tested
 D = nominal pipe diameter, inches
 P = average test pressure during the test, psig.

2. Should any test disclose leakage greater than that allowed, the leaks shall be located and repaired until the leakage is within the specified allowance, without additional cost.
3. Testing New to Existing Connections: New piping connected to existing pipe, existing equipment, existing treatment systems, or tanks and treatment systems furnished under other Sections shall be tested. Isolate the new piping with pipe caps, spectacle blinds, or blind flanges. The joint between new piping and existing piping shall be tested by methods that do not place the entire existing system under the test load. Proceed then, with the testing of new piping systems as specified herein.

3.12 Cleaning

- A. Interim Cleaning: Prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. The piping shall be examined to assure removal of these and other foreign objects prior to assembly and installation.
- B. Flushing: Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity shall be 2.5 fps. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, the pipeline shall be cleaned in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Cone strainers shall be installed in the flushing connections of attached equipment and left in place until cleaning is completed. Accumulated debris shall be removed through drains, or by removing spools or valves.
- C. Disinfection
 1. Disinfect all pipelines which will carry potable water, non-potable water, or hot water. Before acceptance of piping system operation, each section of completed pipeline shall be disinfected in accordance with AWWA C651. After pressure tests have been made, the piping section to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be liquid chlorine, calcium hypochlorite, or sodium hypochlorite. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the piping in an approved manner. PVC pipe lines shall be chlorinated using only the above specified chlorinating material in solution. In no case shall the agent be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. All valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During

the flushing period, each outlet on the line shall be opened and closed several times. From several points in the pipeline section, Contractor personnel, approved by the Engineer, shall take samples in sterilized containers and have a bacterial examination performed by a commercial laboratory in accordance with state approved methods. The commercial laboratory must be certified by the state's approving authority for examination of potable water. The disinfection shall be repeated until the piping system passes the bacterial examination for 2 consecutive days. The piping system will not be accepted until satisfactory bacteriological results have been obtained.

3.13 Waste Water Disposal

- A. Submit the method proposed for disposal of waste water from hydrostatic tests and disinfection, and all required permits, prior to performing hydrostatic tests. The water used for testing, cleaning, flushing and/or disinfection shall be disposed of in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. The method proposed for disposal of waste water shall be provided to, and approved by, the Engineer prior to performing any testing, cleaning, flushing and disinfection activities.

3.14 Manufacturer's Field Services

- A. Submit a signed statement certifying that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance. Obtain manufacturer's technical assistance for Contractor training, installation inspection, start up, and owner operating and maintenance training. Follow manufacturer's instructions for installation.

3.15 Pipe Schedule

FLOW STREAM ABBREVIATION	PROCESS LIQUID	SIZE (INCHES)	PIPE MATERIAL	NOTES	TEST	
CEN	CENTRATE	ALL	DIP	FL / GR	H	100
PW, NPW	POTABLE and NON-POTABLE WATER	ALL	PVC	FL / SOLVENT WELD	H	150
PD	PROCESS DRAIN	ALL	PVC	FL / SOLVENT WELD	H	50
NPY, PY	POLYMER, NEAT POLYMER	ALL	PVC	FL / SOLVENT WELD	H	
SL	SLUDGE	ALL	CPVC		H	150
V	VENT	ALL	DIP/PVC		H	50

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Electric heat tracing systems for tanks and related appurtenances, as shown and required for trouble-free operation, complete and operable.

1.2 Related Work

- A. Section 40 42 00 - Treatment Plant Pipe and Equipment Insulation.
- B. Division 26 General Electrical Requirements.

1.3 Performance Requirements

- A. Environmental Conditions of Items to be Traced.
 - 1. Elevation: Approximately 700 feet above mean sea level.
 - 2. Minimum Outside Ambient Temperature: -15 degrees F.
 - 3. Wind Velocity (Design Condition): 20 miles per hour.
 - 4. Refer to Section 40 42 00 – Process Piping and Equipment Insulation for insulating materials and jackets.
 - 5. Electrical Classification: None.
 - 6. Available Voltage: Refer to Drawings.
- B. Process Conditions:
 - 1. Polymer – Maintain min 60 degrees F.
 - 2. Do not allow fluid temperature to exceed 140 degrees F.

1.4 Submittals

- A. Submit in accordance with Section 01 33 00.
- B. Shop Drawings: The Contractor shall submit complete shop drawings of all heat tracing systems, showing the location of thermostats and interface with electric power supply.
- C. Manufacturer's Data: With the shop drawings, the Contractor shall also furnish complete manufacturer's data of the electric heating cables and the thermostats.
- D. Submit O&M Data in accordance with Section 01 78 23.

- E. Operation Data: Include description of operating controls.
- F. Maintenance Data: Include repair methods and parts list of components.

1.5 Quality Assurance

- A. After completion and testing of the work, including the pipe insulation, the Contractor shall remove all debris from the site, clean all parts of the work including controls and other appurtenances, to hand over each system in perfect operating condition.

Part 2 Products

2.1 General

- A. All equipment and appurtenances shall be provided with heat tracing where shown. Such heat tracing shall consist of spiral wrapping with electrical heating cables or heat panels as recommended by manufacturer. Heat elements shall be subsequently insulated and weatherproofed as specified in Section 40 42 00 - Treatment Plant Equipment Insulation. The heating elements shall be controlled from thermostats installed in representative locations and accessible for adjustment. The heat tracing systems shall be installed complete, including heating elements, power connections, end seals, and controlling thermostats in accordance with the manufacturer's printed installation instructions.

2.2 Polymer Solution Tank-Temperature Control

- A. Tank Heating systems shall be specifically designed for use on Polyethylene tanks. Heating system shall maintain minimum product temperature at 60 degrees Fahrenheit (F) at a maximum delta T of 60 degrees F. Temp shall not exceed 100 degrees F.
- B. Each heating system shall consist of a minimum of two heating pads and a temperature controller. Heating pads shall be adhesive backed panels designed to be applied directly in contact with the tank surface. Minimum of two heating pads each rated at 420 watts, 120 V, mounted 180 degrees apart on the tank.
- C. Thermostats: Provide manufacturers thermostat, factory set to 60 degrees F adjustable for the services specified. Overtemperature shall be set to 100 degrees F.
- D. Manufacturers:
 - 1. HTD Heat Trace Inc.
 - 2. Or Equal.

Part 3 Execution

3.1 Installation

- A. General: The Contractor shall assemble and install all equipment specified herein, in strict accordance with the manufacturer's published instructions. All installations shall be accomplished by competent craftsmen in a workmanlike manner. All heating strips shall be cut in the field and wrapped on the pipelines as required.
- B. Contractor Coordination: The Contractor shall coordinate the installation with the electrical work to ascertain the correct location of all electrical outlets.
- C. Avoid pinching and making sharp bends in cable. Prevent damage by sharp rocks, metal, or other objects during installation.
- D. Temperature Sensor Insulation:
 - 1. All temperature sensors shall be furnished as complete assemblies, including weather head with terminal blocks and mounting hardware.
- E. Heater Power Connection and Splice Boxes:
 - 1. All heater power connections and splices shall be made in NEMA 4 junction boxes mounted outside of pipe insulation and jacketing.
 - 2. Boxes shall be grounded per N.E.C.
- F. All wiring shall be clearly marked and tagged per N.E.C.
- G. Raceway:
 - 1. Liquid tight flexible conduit shall be used for connections to field junction boxes and enclosures. Flexible Conduit connections shall not exceed 3 ft-0 inches in length.
- H. Grounding:
 - 1. A separate grounding connection shall be provided inside each box. Ground connections shall be made with either a servit post type connector or by means of a screw tapped into the metal frame or enclosure. Ground connections shall not penetrate or weaken sealed enclosures and shall not compromise the specified NEMA enclosure standards.
 - 2. Where screw type connections are used, ground wires shall be provided with ring tongue lugs.
 - 3. The tinned copper braid on the self-regulating heater cables shall be grounded by connecting to the ground terminal inside the heater power connection and splice boxes.

I. Nameplates:

1. All major electrical components, instruments, control devices and junction boxes shall be labeled with engraved name plates in accordance with descriptions coordinated with the Owner's requirements.
2. Nameplates shall be made from three ply laminated plastic consisting of two white polished surfaces with a black core. The nameplates shall be 1/16-inch thick, beveled on the face with black letters engraved on white background.
3. Except where otherwise noted, all engraved nameplates shall be permanently attached with stainless steel screws. Attachment of nameplates shall not compromise the required enclosure classification.

J. Circuit Tags:

1. All power circuits and all temperature sensor circuits shall be identified with stainless steel tags attached with stainless steel wire. The tags shall be fastened to the conduit at each junction box, each heater power connection box and each temperature sensor enclosure. A separate tag shall be provided for each circuit entering the box or enclosure.
2. Tags for power circuits shall include the following:
 - a. Part number.
 - b. Circuit number.
 - c. Heater voltage and wattage.

K. End seal and splice locations shall be labeled for future access.

L. Label jackets with "Electrically Traced" warning labels.

3.2 Testing

- A. After completion of its work, the Contractor shall prepare the equipment for operational use in accordance with the manufacturer's printed instructions.
- B. Test continuity of heater cable.
- C. In the field, all heater cables shall be meggered with a minimum of 500 volts dc. The following separate field megger readings shall be taken on each self-regulating heater cable. All megger readings shall be greater than 20 megohms. Any cable failing any test shall be replaced completely.
 1. When cable is received at job site before installation.

2. After installation, before insulation is applied.
 3. After insulation is applied.
- D. Measure voltage and current at each unit.

3.3 Acceptance

- A. Final acceptance of the equipment is contingent on satisfactory appearance and operation after installation.

END OF SECTION

Part 1 General

1.1 Work Included

- A. The Contractor shall furnish and install all pipe and equipment insulation, complete and operable, in accordance with the requirements of the Contract Documents. Insulate all new and existing water piping designated as CW, DW, PW and NPW.

1.2 Related Sections

- A. Section 09 90 15 - Paints.
- B. Section 40 05 06 - Couplings, Adapters, and Specials for Process Piping.
- C. Section 40 05 07 - Pipe Hangers and Supports.
- D. Section 40 05 09 - Wall Pipes, Floor Pipes, and Pipe Sleeves.
- E. Section 40 05 97 - Identification for Process Equipment.
- F. Section 40 41 00 - Process Equipment Heat Tracing.

1.3 Submittals

- A. Submittals shall be made in accordance with Section 01 33 00. Submit the Shop Drawings, Product Data, and Manufacturer's Instructions at the same time for each system.
- B. Shop Drawings: Provide shop drawings for MICA Plates, Pipe Insulation Systems and Associated Accessories, and Equipment Insulation Systems and Associated Accessories.
- C. Product Data: Provide product data and certification for Pipe Insulation Systems and Equipment Insulation Systems.
- D. Samples: Thermal Insulation.
- E. Manufacturer's Instructions: Provide manufacturer's instructions for installation of Pipe Insulation Systems and Equipment Insulation Systems.

1.4 Delivery, Storage, and Handling

- A. Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Engineer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall

have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable). Insulation packages and containers shall be asbestos free.

1.5 Cleanup

- A. After completion of all insulation, the Contractor shall remove all debris from the site and clean all parts of the work to hand over the system in perfect condition.

Part 2 Products

2.1 General

- A. Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. Materials furnished under this section shall be submitted together in a booklet and in conjunction with the MICA plates booklet. Annotate the product data to indicate which MICA plate is applicable.
- B. Insulation System: Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for water piping systems that are located within, on, under, and adjacent to buildings. Insulation shall be CFC and HCFC free.
- C. All components of the insulation, including covering, mastics and adhesives shall have a flame-spread rating of not over 25, and a smoke development rating of not over 50. Ratings shall be as established by tests in accordance with ASTM E 84 and Federal Specification standards. The integrated insulation assemblies shall also conform to the above specifications. Insulation shall be applied in strict accordance with the manufacturer's instructions.

2.2 Basic Materials

- A. Standard Insulation: This type of insulation shall be employed for water piping and equipment. Pipe insulation and jacketing shall be applied to all exposed piping and shall include fittings, flanges and valves. Pipe insulation shall be molded-type pipe covering, made of fibrous glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature. Unless otherwise specified, the insulation thickness shall be as follows:

Process Piping and Equipment Insulation

Pipe Insulation	Minimum Thickness of Insulation (inches)
Hot and cold water 6-inches and smaller	1-1/2
Equipment and Tanks:	3

- B. The insulation shall be oversized for installation over electric heating cable. Insulation shall have a factory-applied white fire-retardant vapor-barrier jacket of kraft paper and aluminum foil laminated together and reinforced with fiberglass yarn.
- C. Fittings and valves shall be covered with the same material as the pipe, cut in segments to fit snugly without open spaces, held in place with wire or cement, and then covered with the same jacketing material as the pipe.
- D. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-barrier cement before installation of the finish jacket. Pipe insulation and vapor-barrier shall be continuous through hangers and supports. Insulation shall be coordinated with the pipe hangers and supports and where insulation protection shields are provided the top half section of pipe insulation at support locations shall be of the same specified density, and the bottom half insulation segments provided between the pipe and the insulation protection shields shall have a density of not less than 6 lb/cu ft.
- E. All insulation shall be covered with smooth aluminum weatherproof metal or plastic preformed jacketing with a factory-attached moisture barrier. The jacket for the fittings shall consist of precision-formed smooth-sided sections and shall be sized to cover and protect the insulated fitting. Each section shall be manufactured from aluminum or PVC, and all joints shall be sealed with silicon mastic or solvent welding, to provide a continuous, air and weathertight joint.
- F. Manufacturers:
 - 1. Owens Corning; Fiberglas Pipe Insulation
 - 2. Johns-Manville; Micro-Lok Pipe Insulation
 - 3. Thomas Insulation Corporation

2.3 Accessories

- A. Aluminum Jackets: Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 by 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

- B. Polyvinyl Chloride (PVC) Jackets: Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.
- C. Insulation Bands: Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.
- D. Wire: Soft annealed ASTM A580 Type 302, 304 or 316 stainless steel, 16 or 18 gauge.
- E. Mineral Fiber Insulation Cement: Cement shall be in accordance with ASTM C195.

2.4 Equipment Insulation Systems

- A. Insulate equipment and accessories as specified above. Increase the specified insulation thickness for equipment where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface. Submit a booklet containing manufacturer's published installation instructions for the insulation systems in coordination with the submitted MICA Insulation Standards plates booklet. Annotate their installation instructions to indicate which product data and which MICA plate are applicable. The instructions must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation.

Part 3 Execution

3.1 Installation

- A. All insulation shall be installed by a qualified insulation Contractor in strict accordance with the manufacturer's recommendations and the requirements of these specifications.
- B. All piping insulation shall be installed following required testing and approval of piping by the Engineer.
- C. General Requirements: All pipe lines noted on the drawings shall be insulated in accordance with these specifications. Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type I jacket or field applied aluminum where required or seal welded PVC.
- D. Insulation for Fittings and Accessories
 - 1. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant. Insulation shall be marked showing the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.
 - 2. Precut or Preformed: Place precut or preformed insulation around all fittings and accessories. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity.

3. Rigid Preformed: Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".
- E. Piping Exposed to Weather: Piping exposed to weather shall be insulated and jacketed. After this procedure, a laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, greater than 3 ply, standard grade, silver, white, black and embossed aluminum jacket or PVC jacket shall be applied. PVC jacketing requires no factory-applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not furnished.
1. Aluminum Jacket: The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping shall be sealed with a moisture retarder.
 2. Insulation for Fittings: Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, greater than 3 ply, standard grade, silver, white, black and embossed, and UV resistant.
 3. PVC Jacket: PVC jacket shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion

3.2 Equipment Insulation Systems Installation

- A. Install equipment insulation systems in accordance with the approved MICA Insulation Standards plates as supplemented by the manufacturer's published installation instructions.
1. General: Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:
 - a. Hand-holes.

- b. Cleanouts.
- c. ASME stamps.
- d. Manufacturer's nameplates.

B. Tank Insulation

1. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
2. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers. Insulation corners shall be protected under wires and bands with suitable corner angles.
3. Cellular glass shall be installed in accordance with manufacturer's instructions. Joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating.
4. Exposed insulation corners shall be protected with corner angles.
5. Insulation on equipment with ribs shall be applied over 6 by 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Engineer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inches washers or shall be securely banded or wired in place on 12 inch centers.
6. Vapor Retarder/Vapor Barrier: Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating or vapor barrier jacket shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Flashing sealant or vapor barrier tape shall be applied to parting line between equipment and removable section insulation.

C. Tank Insulation Finish

1. Installation: After the above insulation is accomplished, the insulation shall then be further finished. Two coats of weather barrier mastic reinforced with fabric or mesh for outdoor application shall be applied to the entire surface. Each coat of weatherproof mastic shall be 1/16 inch minimum thickness. The exterior shall be a metal jacketing applied for mechanical abuse and weather protection, and secured with screws or vapor barrier/weatherproofing jacket less than 0.0000 permeability greater than 3 ply, standard grade, silver, white, black, and embossed or greater than 8 ply, heavy duty white and natural. Membrane shall be applied overlapping material by 3 inches. No bands or caulking needed-see manufacturer's recommend installation instructions.

2. Optional Panels: At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance shall be equal to or better than that specified for field installed insulation.

END OF SECTION

Part 1 General

1.1 Work Included

- A. Common Requirements for Plant Control System.

1.2 Definitions

- A. Definitions, Symbols, and engineering unit abbreviations shall conform to IEEE Standards Dictionary, as applicable.

1.3 Submittals

- A. Submit the following in accordance with Section 01 33 00 - Submittal Procedures. Partial submittals will not be accepted.
- B. Bill of Materials: List of required equipment.
 - 1. Group required equipment items by process area and enclosure, and within an enclosure as follows:
 - a. Process Control Components: By component identification code.
 - b. Other Equipment: By equipment type.
 - 2. Data required:
 - a. Equipment tag number.
 - b. Description.
 - c. Manufacturer, complete model number, and all options not defined by model number.
 - d. Quantity supplied.
 - e. For panels, include panel reference number and name plate inscription.
- C. Catalog Cut Sheets: For all new process control components, electrical devices, and mechanical devices:
 - 1. Catalog information, clearly marked to identify proposed items and options provided.
 - 2. Descriptive literature.
 - 3. External power and signal connections.

4. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
- D. Panel Construction Drawings for Modified Existing Panels (Sludge Prep RTU MCP 0101, Centrifuge RTU MCP 0101, Thickener RTU MCP 0103, LCMR00 Dewatering Foxboro Panel, and Foxboro Cabinet Fiber Switches)
1. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, and subpanels, both internal and external.
 2. Panel Legend (Bill of Materials): List front of panel devices by tag numbers, nameplate inscriptions, and service legends.
 3. Bill of Materials: List devices mounted within panels which are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 4. Construction Details: NEMA rating, materials, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other construction callouts and details.
 5. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
- E. Panel Wiring Diagram for Modified Existing Panels (Sludge Prep RTU MCP 0101, Centrifuge RTU MCP 0101, Thickener RTU MCP 0103, LCMR00 Dewatering Foxboro Panel, and Foxboro Cabinet Fiber Switches):
1. Cover wiring within a panel including, but not limited to, instrumentation, control, power, communications, and digital networks. Provide information for wiring panels, making panel connections, and future panel trouble shooting.
 2. Diagram Type:
 - a. Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
 - b. Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.
 - c. Item identification: Identify each item with attributes as listed below.
 - 1) Wires: Wire number and color. Cable number if part of a multi-conductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
 - 3) 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.
 - 4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
 - 5) 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. Clearly indicate normally closed contacts.
 - 6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
 - 7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
 - d. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.
 - e. Wire and Cable Names: Show names and wire colors for circuits entering and leaving a panel.
- F. Loop Wiring Diagrams for Modified Existing Panels (Sludge Prep RTU MCP 0101, Centrifuge RTU MCP 0101, Thickener RTU MCP 0103, LCMR00 Dewatering Foxboro Panel, and Foxboro Cabinet Fiber Switches): Individual, end-to-end wiring diagram for each analog, discrete, or equipment loop.
- 1. Conform to requirements of ISA S5.4.
 - 2. Show loop components within a panel and identify each component, component terminals, and panel terminals.
 - 3. If a loop connects to panels or devices not provided under this Section and its related sections, such as control valves, motor control centers, package system panels, and variable speed drives, provide the following information:
 - a. Show the first component connected to within the panel or device that is not provided under this Section and its subsections.
 - b. Identify the component by tag and description.
 - c. Identify panel and component terminal numbers.

4. Provide one drawing per I/O module. Show all PLC I/O. No “typical” loop diagrams will be allowed.
 5. Show:
 - a. Terminal numbers, location of dc power supply, and location of common dropping resistors.
 - b. Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
 - c. Tabular summary on each analog loop diagram:
 - 1) Transmitting Instruments: Output capability.
 - 2) Receiving Instruments: Input impedance.
 - 3) Loop wiring impedance: Estimate based on wire sizes and lengths shown.
 - 4) Total loop impedance.
 - 5) Reserve output capacity.
 - d. Circuit and raceway schedule names.
 6. Drawing Size: Individual 11-inch by 17-inch sheet.
- G. Communications Networks Diagrams for Modified Existing Panels (Sludge Prep RTU MCP 0101, Centrifuge RTU MCP 0101, Thickener RTU MCP 0103, LCMR00 Dewatering Foxboro Panel, and Foxboro Cabinet Fiber Switches):
1. Include connections to new and existing Ethernet and Fiber Optic network.
 2. Network schematic diagrams for each different type of network.
 3. Show:
 - a. Interconnected devices, both passive and active.
 - b. Device names and numbers.
 - c. Terminal numbers.
 - d. Communication Media: Type of Cable.
 - e. Connection Type: Type of connector.
 - f. Node and device address numbers.
 - g. Wire and cable numbers and colors.

- H. Panel Power Requirements and Heat Dissipation: For control panels, tabulate and summarize:
 - 1. Required voltages, currents, and phases.
 - 2. Maximum heat dissipation in Btu per hour.
 - 3. Steady State Temperature Calculations: For non-ventilated panels, provide heat load calculations showing the panel estimated internal steady state temperatures for ambient air temperatures of 90 degrees F.
- I. Provide updated PLC I/O List for Modified Existing Panels (Sludge Prep RTU MCP 0101, Centrifuge RTU MCP 0101, and Thickener RTU MCP 0103). I/O List shall include new and existing.

1.4 Field Training

- A. Field training oriented to the specific system shall be provided for designated personnel.
- B. Furnish a copy of the training manual for each trainee plus two additional copies.
- C. Manuals shall include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson.
- D. Furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals shall be delivered with the printed training manuals.
- E. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.
- F. Submit the training manual and schedule to receive approval from the Engineer at least 30 days before the training.
- G. Preliminary Operator Training
 - 1. Prior to the start of field testing, preliminary operator training shall be taught at the project site for one training day.
 - 2. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system.
 - 3. This course shall include: general system architecture; functional operation of the system, including workstations; operator commands; application programs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files.

H. Additional Operator Training

1. Following the field testing, additional classroom training for operators shall be taught for one training day, consisting of two individual instruction sessions of 4-hours each in the morning and afternoon of the same day.
2. Individual instruction shall consist of "hands-on" training under the constant monitoring of the instructor.
3. Classroom training shall include instruction on the specific hardware configuration of the installed control system and specific instructions for operating the installed system.
4. Schedule activities during this period so that the specified amount of time on the equipment will be available for each student.
5. The final session will address specific topics that the students need to discuss and to answer questions concerning the operation of the system.
6. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed control system.
7. Each student should be able to start the system, operate the system, recover the system after a failure and describe the specific hardware architecture and operation of the system and be fully proficient in all system operations.
8. Report the skill level of each student at the end of this course.

Part 2 Products

2.1 System Description

- A. The process instrumentation and control system (PICS) shall be used to monitor and control the operation of process equipment as specified and in accordance with the sequence of control and control schematics shown on the drawings. The control system shall provide for operator interaction, overall control system supervision, and process equipment control and monitoring.
- B. The PICS supplier shall modify all existing control panels shown on the P&IDs and is responsible for all PLC and HMI programming and interfacing with the new Flottweg Centrifuge Control Panel #1 (LCP 8510) and #2 (LCP 8520) and the Spirac Conveyor Control Panel (LCP 8525).
- C. Provide hardware configured and sized to support expansion as specified and shown on the drawings.

D. Operation

1. The control system provided under this specification shall operate using direct digital control (DDC) algorithms or ladder logic type and supervisory control to provide the required sequences of operation.
2. Input data to the controller shall be obtained by using instruments and controls interfaced to mechanical, electrical, utility systems and other systems as shown and specified.
3. The number and location of control panels shown on drawings shall be provided as a minimum.

E. Points

1. Each connected analog output (AO), analog input (AI), digital output (DO), digital input (DI), pulse accumulator (PA) input and other input or output device connected to the control system shall represent a "point" where referred to in this specification.

F. Data Transmission Systems (DTS)

1. Provide data transmission systems for communication between PLCs and the central station as specified in and as indicated on the drawings.

2.2 Materials and Equipment

A. Standard Products: Materials and equipment must be standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products. Units of the same type of equipment shall be products of a single manufacturer. Items of the same type and purpose shall be identical and supplied by the same manufacturer, unless replaced by a new version approved by the Engineer.

B. Nameplates:

1. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place.
2. Laminated plastic nameplates shall be provided for equipment devices and panels furnished. Each nameplate shall identify the device, utilizing the designations shown on the P&ID's, such as pump "P-1001" or valve "V-0012".
3. Labels shall be coordinated with the schedules and the process and instrumentation drawings.
4. Laminated plastic shall be 1/8 inch thick, white with black center core.
5. Nameplates shall be a minimum of 1 by 3 inches with minimum 1/4 inch high engraved block lettering.

6. Nameplates for devices smaller than 1 by 3 inches shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the device.

2.3 General Requirements

- A. Equipment located outdoors, not provided with climate-controlled enclosure, shall be capable of operating in the ambient temperature range indicated in paragraph ENVIRONMENTAL CONDITIONS, unless otherwise specified.
- B. Electrical equipment will conform to Division 26. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

2.4 Monitoring and Control Parameters

- A. The control system shall be complete including sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, engineering units conversions and algorithms for the applications; and shall maintain the specified end-to-end process control loop accuracy from sensor to display and final control element.
- B. Control equipment shall be powered by a 120 V ac, single phase, 60 Hz power source, with local transformers included as needed for signal transmission and subsystem operation.
- C. Connecting conductors shall be suitable for installed service.

2.5 Existing Control Panels

- A. Sludge Prep RTU MCP 0101
 1. Provide and program new Modicon M340 PLC processor to be installed in existing control panel.
 2. Provide migration hardware to communicate to existing SLC 5/04 I/O cards.
 3. Provide fiber to copper converters as shown on the drawings.
 4. Provide fiber patch panels as shown on the drawings.
 5. Provide new 6" HMI display on front of existing enclosure.
 6. Existing enclosure shall remain.
- B. Centrifuge RTU MCP 0102
 1. Provide and program new Modicon M340 PLC processor to be installed in existing control panel.
 2. Provide migration hardware to communicate to existing SLC 5/04 I/O cards.

3. Provide fiber to copper converters as shown on the drawings.
 4. Provide fiber patch panels as shown on the drawings.
 5. Provide new 6" HMI display on front of existing enclosure.
 6. Existing enclosure shall remain.
- C. Thickener RTU MCP 0103
1. Provide and program new Modicon M340 PLC processor to be installed in existing control panel.
 2. Provide migration hardware to communicate to existing SLC 5/04 I/O cards
 3. Provide fiber to copper converters as shown on the drawings.
 4. Provide fiber patch panels as shown on the drawings.
 5. Provide new 6" HMI display on front of existing enclosure.
 6. Existing enclosure shall remain.
- D. LCMR00 Dewatering Foxboro Panel
1. Provide new communication modules to communicate with new Modicon PLC and new Central Station Workstation.
 2. Panel is being relocated.
 3. Existing enclosure shall remain.
- E. Foxboro Cabinet Fiber Switches
1. Existing cabinet to remain.

2.6 Central Station Workstation Equipment

- A. Workstation Computer
1. Computing devices, as defined in 47 CFR 15, supplied as part of the control system shall be certified to comply with the requirements of Class B computing devices and shall be labeled as set forth in 47 CFR 15.
 2. Computer shall be a standard desk top configuration, unmodified digital computer of modular design.
 - a. Minimum Processor Operating Speed: Minimum dual micro processors with minimum processor operating speed of 3.06GHz
 - b. RAM Memory: Ram memory shall be 2GB

- c. Power Supply: Minimum power supply shall have a capacity of 750 watts. Suspend to RAM (S3) sleep support with wakeup capabilities.
- d. Real Time Clock (RTC): Real time clock accurate to within plus or minus one minute per month. Battery backed for a minimum of 3 months.
- e. Input/Output (I/O) Ports:
 - 1) 1 PS/2 keyboard 101 key, 64 character standard ASCII character set based on ANSI INCITS 154 with 8 programmable hotkeys.
 - 2) 1 PS/2 2-button mouse: minimum resolution of 400 dots per inch.
 - 3) One serial TIA-232 ports. Data transmission rate shall be software adjustable between 9600 and 57,600 bps.
 - 4) 1 enhanced parallel port.
 - 5) 1 Ethernet.
 - 6) 8 USB ports, 2 in front and 6 in rear.
 - 7) 1 graphic.
 - 8) 1 microphone.
 - 9) 1 audio in.
 - 10) 1 audio out.
 - 11) 1 headphone.
 - 12) 1 IEEE 1394 controller card.
- f. SVGA Color Monitor: SVGA color monitor shall be no less than 24 inches, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 millimeters.
- g. Graphics Card: EVGA – GeForce RTX 2080 Ti or equal
- h. Hard Disk: Hard disk with a minimum of 1 terabyte of formatted storage.
- i. CD Drive:
- j. Network Interface Card

B. Uninterruptible Power Supply (UPS)

- 1. A self-contained UPS suitable for installation and operation at the central station shall be provided. The unit shall be sized to provide a minimum of 10 minutes of operation of the central station computer. The UPS shall incorporate surge

suppression, noise filtering (normal and common mode) short circuit protection and voltage regulation (brownout and overvoltage protection).

2. UPS shall be complete with all necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power. The UPS shall comply with the Federal Communications Commission Standard 15J part A for radio noise emissions.

2.7 Central Station Software

- A. The central station software shall provide the communication, programming and control capabilities necessary to support all specified points and functions, plus a minimum expansion of 50 percent of the current number of points, complete with their point database.
- B. The central station shall be online at all times and shall perform all required functions as specified.
- C. The central station software shall conform to the requirements of Dalton Utilities.
- D. The system shall support multiple user operation with multiple tasks for each user and shall support operation and management of all peripheral devices.
- E. Graphical Operations
 1. Graphical User Interface: The central station shall be provided with an object-oriented, mouse driven, graphical user interface. The graphical user interface shall include a set of desktop utilities including the following: file management; shell tool; calculator; text editor; and icon editor.
 2. Display Information: The central station shall display information necessary to support all requirements specified, including: operator commands; alarm notification; reports; system graphics as specified and as shown, incorporating dynamic data; and curve plotting.
 3. System Graphics Implementation: System graphics displays shall be hierarchical displays which integrate dynamic data into the display. System graphics shall reflect actual system configuration. Each system schematic shall be included as a separate display. Different colors, textures, and use of inverted video shall be used for various components and dynamic data. The displays shall include standard and/or custom symbols. A library of callable display symbols containing symbols for all necessary equipment and control devices shall be furnished. Symbols shall conform to ASHRAE FUN IP where applicable. Data associated with a display shall be updated within 5 seconds of the digital status change or the analog change in excess of the analog change differential. Any dynamic data which is not current, due to PLC communications failure, PLC failure, or point out of service, shall be highlighted or flagged.
 4. Display Editor: The display editor shall enable the user to create, modify, save and delete displays and symbols. Within the display shall be dynamic fields.

The function of linking the dynamic fields with the database shall be handled by a separate software module which shall be executed automatically as the last step of the database generation and modification procedure.

5. Graphical Object-Oriented Programming: The system shall include a graphical object-oriented programming function which shall be used to create all control sequences utilized in the control panels. This function shall reside in the central station to create, modify, and test software for control panel resident programs. The graphical object-oriented programming function shall provide programming elements to be connected together to create a logic diagram. The diagram shall be compilable to produce executable code for the control panel. The graphical object-oriented programming function shall include elements necessary to create logic diagrams that represent sequences of operation. Program elements shall be able to be combined into a custom template which can then be used as a standard function. Program checkout and debug facilities shall include display of dynamic and/or simulated system variables and points on the programming screens. The user shall be able to fix or force values of variables to enable program checkout during debugging. The programming shall allow for the use of the portable tester for loading files directly into the control panel, uploading of existing control panel programming and database information and downloading of control panel programming and database information.
6. Charting: The user shall be able to display data in chart formats, and the system shall support the presentation of data:
 - a. with time on the X-axis (horizontal) and amplitude on the Y-axis (vertical) for trend charts; and
 - b. in bar chart form with a minimum of 360 15-minute divisions and 31 1-day divisions to be displayed on the X-axis.
7. System Menus and Displays: The user shall be able to call up the following displays by dedicated function key, pull down menu or by icon and shall be able to page forward and backward on linked multiple page displays. The system menu and index displays shall also contain icons which can be used to call up subsequent displays.
 - a. System Menu (list of all graphics and menus).
 - b. Index (list of all PLCs).
 - c. Alarm Summary (list of all uncleared alarms).
 - d. Abnormal Summary (list of all devices not in normal state; keeps track of alarm conditions which have been cleared).
 - e. Data Communications Summary (listing of availability for each communication channel, by statistically processing the number of transmission errors, outages, and other abnormal conditions for each channel).

8. Hard-Copy Screen Request: The central station shall be able to obtain a hard copy of the monitor display being viewed. This shall be an exact "snapshot" of the data and device symbols shown on the selected monitor.
9. Command Software: The software shall provide for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands shall be usable from central station computer and workstation keyboards with individual operator passwords as specified.
10. Command Input: Command menus shall utilize full words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system shall prompt the operator.
11. Command Input Errors: The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors.
12. Special Functions: The system shall support the following special functions by using a mouse, in addition to all other commands specified:
 - a. Help: produce a display of all commands available to the operator. The help command, followed by a specific command, shall produce context sensitive listing with a short explanation of the purpose, use, and system reaction to that command.
 - b. Start/Enable: Manually start equipment and enable monitoring and control of points.
 - c. Stop/Disable: Manually stop equipment and disable monitoring and control components.
 - d. Display Diagram: Display diagrams of specific utility systems or other systems.
 - e. Diagram Development: Facilitate development of diagrams of specific utility systems or other systems.
 - f. Auto/Override: Override automatic operation of a point or return a point to automatic operation.
 - g. Print Report: Allow the operator to print reports.
 - h. Confirm Action: Allow the operator to confirm that the desired command sequence has been correctly entered and is to be executed.
 - i. Cancel Action: Perform the opposite function of the confirm action, at any time prior to executing confirm action.
 - j. Memo Pad: Allow the operator to create, store and retrieve pop-up notes.

- k. Operator's Commands: The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. The operator's commands shall perform such tasks as requesting a display of any digital, analog, or accumulator point, or any group of related points, startup and shutdown selected systems or devices, modifying, adjusting, enabling or defining a point or point parameters.
- 13. Level of Addressing: Provide four levels of addressing for identification as follows:
 - a. Point: The individual sensor or control device within a unit.
 - b. Unit: The unit that a point is associated with, such as a blower.
 - c. Sub-System: The sub-system that a point is located in or near.
 - d. System: The system that a sub-system is located in or near.
- F. System Access Control: Access control shall be conform to Dalton Utilities existing standards.
- G. Alarms:
 - 1. The software shall notify an operator of the occurrence of an alarm condition. The control system alarm history shall be stored in an ASCII file and shall be recallable by the operator using the report generator. Alarm messages shall take precedence over other functions. A minimum of the most recent 25 system alarms shall be directly available at the central station computer. Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms. Alarm data to be displayed and stored shall include: identification of the alarm; date and time to the nearest second of occurrence; device or sensor type; limit exceeded (if analog); engineering units; current value or status; alarm class; and alarm messages.
 - 2. Digital Alarms: Digital alarms shall be subject to immediate reporting, within the alarm response time, at the central station.
 - 3. Analog Alarms: These alarms shall be subject to immediate reporting, within the alarm response time, at the central station. The control panel analog readings shall be compared to predefined high and low limits and alarmed to the central station each time a value enters or returns from a limit condition. The program shall automatically change the high or low limits, or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the new alarm limit becomes effective. For those applications where setpoint adjustments are made, the alarm limit shall be keyed to a finite deviation traveling with the setpoint.
 - 4. Alarm Messages: A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to a point shall be an

operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator.

5. Alarm Classes: Classes of alarms, which will be identified for each item, include class 1 and class 2 alarm conditions.
 - a. Class 1 (Critical) shall include display, print, and audible alarm at occurrence and at return-to-normal. Acknowledgment of class 1 alarms by the operator shall be required at occurrence and at return-to-normal.
 - b. Class 2 (Informational) shall include display, print, and audible alarm at occurrence and at return-to-normal. No acknowledgment of class 2 alarms is required unless otherwise shown.
- H. Pop-up Note Function: A pop-up note function shall be included with the central station, providing the operator a capability of noting any data which may be associated with alarms or with any other event. A note created by an operator shall be automatically called up when any other workstation calls up the associated point, alarm, or alarm summary. The pop-up note function shall also support free form entry of data which can be used by any workstation operators as general reminders or instructions.
- I. Real Time Clock Synchronization: The system shall synchronize each central station computer, real time clock, within one second and at least once per day automatically, without operator intervention and without requiring system shutdown. The central station computer shall automatically initiate a call once per day to the NIST clock to obtain the correct time and date and update the real time clock. The central station computer shall generate a report showing the time difference.
- J. System Reaction: Under system normal heavy load, no more than 10 seconds shall lapse from the time a digital status alarm or analog alarm occurs at a PLC until the change is displayed at the central station. The total system response time from initiation of a control action command to display of the resulting status change shall not exceed 20 seconds under system normal heavy load conditions, assuming a zero response time for operation of the PLC's control device. The alarm printer shall continue to print out all occurrences, including time of occurrence, to the nearest second. All system normal heavy load conditions shall be introduced to the system via AIs and DIs.
 1. Occurrence: System normal heavy load conditions are defined as the occurrence throughout the system of a total of three status changes, three digital alarms, three analog high or low limit alarms, and three analog quantity changes within the high and low limits during a single 1-second interval. This number of similar occurrences shall repeat on a continuous basis during successive 1-second intervals for a period of 2 minutes.
 2. Location: System normal heavy load conditions, as specified, shall have 50 percent of the changes and alarms, including no less than one of each type, occurring at a single PLC with the remaining changes and alarms distributed among the remaining PLCs.

K. Report Generator

1. Software shall be provided to generate and format standard and custom reports for displaying, printing, and storing on disk. Reports shall use database values and parameters, values calculated using the real time static database or historical data base; with the reports subsequently stored on hard disk or zip drive. Dynamic operation of the system shall not be interrupted to generate a report. The report shall contain the time and date when the sample was taken, and the time and date when the report was printed.
2. Periodic Automatic Report: The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.
3. Request Report Mode: The system shall allow for the operator to request, at any time, an immediate printout of any report.

L. Data Interchange: Software shall be provided to format and store on a removable media the data, trends, profiles, reports and logs as specified in a defined, standard format such as ASCII text or DIF for export and further processing by other software and/or computer systems.

M. Control Panel and DTS Circuit Alarms: The system shall supervise each control panel, I/O function and DTS circuit for alarm reporting, including: control panel not responding; control panel responding (return to normal); control panel to central station DTS circuit high error rate; control panel to control panel DTS circuit high error rate; control panel/central station real time clock error more than 15 seconds (adjustable); control panel intrusion alarm; control panel offline; control panel online (return to normal); control panel failure (self-diagnostics); point not responding to command; and point change of state without command.

N. Central Station Database: The central station database shall be stored on disk and in memory. The static database shall be downloadable as required to control panels in the system.

1. Database Definition Process: Software shall be provided to define and modify each point in the database using operator commands. The definition shall include all physical parameters and constraints associated with each point. Each database item shall be callable for display or printing, including EEPROM, ROM and RAM resident data. Each point shall be defined and entered into central station database.
2. Dynamic Database: The dynamic database includes those variables which change with time or conditions including all DIs, AIs, PAs, and virtual (logic) points.
 - a. Dynamic Database Update: The dynamic database shall be updated from the field, allowing the operator to select update times from 0.1 seconds to 2.0 seconds.

3. Static Database: The static database includes those fixed parameters and constraints from all PLCs which define the characteristics of the system and I/O functions such as alarm limits, start/stop times, point names, PLC channel addresses, and sensor spans.
 - a. Central Station Static Database Update: A copy of each control panels static database shall be updated automatically once per day, each time an authorized change is submitted or upon demand from the central station database.
 4. Workstation Access to Dynamic Data: Any workstation with proper access password and connected to the central station via the DTS, or via a dial-up telephone circuit, shall have access to the central station's dynamic data. Display of data shall commence within 5 seconds.
- O. Historical Data Storage and Retrieval: A historical data storage and retrieval function shall be provided at the central station to collect and store dynamic data. This function shall be in addition to other data storage requirements. The function shall have the capability to collect and store alarm status changes, point values, events and operator commands, and system responses. The storage function shall also have the capability to collect and store multiple sets of analog data at pre-specified sampling rates. This function shall have the capability to retain historical data on hard disk for pre-specified time periods, up to forty five days using last day roll over, for short-term analysis, and then output the data to the removable media for long-term retention. The operator shall also be able to selectively recall short-term data stored on hard disk. Retrieval and printing of the contents of any selected historical data file shall be available using the data retrieval and report generation program. The output of the report generation program shall be capable of being viewed on the screen, printed in a report, or stored.
- P. Trending: Any analog or calculated point shall be operator assignable to the trend program. Points shall be sampled at individually assigned intervals, selectable between one minute and 24 hours. The system shall automatically store the accumulated trend data to an ASCII disk file. The size of the trend data file shall be limited only by available disk space. The program shall print portions of the file as selected by the operator.
- Q. Analog Monitoring: The system shall measure, transmit, and display analog values, including calculated analog points. Differential measurements shall be displayed as positive or negative values with respect to their reference points shown. An analog change in value is defined as a change exceeding a preset differential value as specified. Each analog change in value shall be operator selectable and settable to provide for a minimum reporting change in value of one-half the specified end-to-end accuracy of the measured variable. Displays and reports shall express analog values in proper engineering units with sign. Provide 128 different sets of engineering unit conversions. Each engineering conversion unit shall include range, span, and conversion equation.
- R. Analog Totalization: Any analog or calculated point shall be operator assignable to the totalization program. The analog totalization time period shall be defined uniquely for each point. At the end of the period, totals shall be stored on disk for future

reference. Totalization shall then restart from zero for the next time period. The program shall keep track of the peak and total value measured during the current period and for the previous period. The operator shall be able to initiate a summary of totalization information on a point, unit, sub-system or system. The operator shall be able to set or reset each totalized value individually. The operator shall be able to define, modify, or delete the time period online.

- S. LAN Software: A network operating system shall be supplied as part of the LAN software. The network operating system shall support network device access to the central station. The system shall provide workstation access to the central station as a virtual terminal. The network shall provide network access to shared peripherals. The LAN software shall provide for transparent communication with any node on the system. The LAN software shall support the following:
 - 1. Access Control: Access control to the central station computer and workstations. Operators shall be able to perform all specified functions, given the proper passwords, including database definition/modification, graphic creation/modification, and trending.
 - 2. Multiple Sessions: Support operation in multiple sessions.
 - 3. Other Functions and Configurations: Other functions and configurations shown.

Part 3 Execution

3.1 Examination

- A. Verify the following conditions for all equipment not provided by process instrumentation subcontractor, but which interfaces with process control system:
 - 1. Proper installation.
 - 2. Calibration and adjustment of positioners and transducers.
 - 3. Correct control action.
 - 4. Switch settings and dead bands.
 - 5. Opening and closing speeds and travel stops.
 - 6. Input and output signals.

3.2 Equipment Installation Requirements

- A. Installation
 - 1. Install system components and appurtenances in accordance with the manufacturer's instructions and provide necessary interconnections, services,

and adjustments required for a complete and operable system. Adjust or replace devices not conforming to the required accuracies.

- a. Replace factory sealed devices, rather than adjusting.
2. Install instrumentation and communication equipment and cable grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
3. Install wiring in exposed areas, including low voltage wiring, in metallic raceways or EMT conduit as specified in Section 26. Wiring in air plenum areas installed without conduit shall be plenum-rated in accordance with NFPA 70.
4. Submit detail drawings containing complete piping, wiring, schematic, flow diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Include in the Drawings, as appropriate: product specific catalog cuts; a drawing index; a list of symbols; a series of drawings for each control system using abbreviations, symbols, nomenclature and identifiers as shown; valve schedules; compressed instrument air station schematics and ASME air storage tank certificates for each type and make of compressed instrument air station.

B. Isolation, Penetrations and Clearance from Equipment

1. Dielectric isolation shall be provided where dissimilar metals are used for connection and support.
2. Penetrations through and mounting holes in the building exteriors shall be made watertight.
3. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials.
4. Openings shall be sealed with materials which meet the requirements of NFPA 70.
5. Installation shall provide clearance for control-system maintenance.
6. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

C. Device Mounting

1. Devices shall be installed in accordance with manufacturers' recommendations and as shown.
2. Field Mounting: All field mounted instruments which are not self-supporting shall be mounted on 2 inch extra-strong 316 Stainless steel pipe stands.

3. Location and Access: All field mounted instrumentation shall be located near platforms, walkways, etc., to allow easy access for maintenance and adjustments.
4. Clearance at Aisles and Access Ways: Connections shall be made so that instruments or instrument piping do not obstruct aisles or access ways.
5. Local or Field Located Panels: All back-of-panel construction (conduit runs, tubing racks, braces, etc.) shall be installed to avoid interference with future full utilization of panel space and shall be properly supported and installed in a neat and orderly manner.
6. Control devices to be installed in piping shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration.
7. Any deviations shall be documented and submitted to the Engineer for approval prior to mounting.
8. Damaged insulation shall be replaced or repaired after devices are installed to match existing work.
9. Damaged galvanized surfaces shall be repaired by touching up with zinc paint.

D. Instrument Piping and Tubing

1. Tubing System Installation:
 - a. All instrument piping and tubing shall be installed in a neat workmanlike manner, and show no signs of crimping, bends of too short radius, flattening, etc. Extreme care shall be exercised to keep foreign matter out of the system. All open tubing ends and connections shall be kept plugged to keep out dust, dirt, moisture, etc.
 - b. The tubing shall be permanently mounted, supported, and protected in channels.
 - c. Metal tubing supplied in the "Soft-Drawn" conditions or in coils shall be carefully straightened before installation by stretching.
 - d. Each tube shall be tagged, at each end, with its identifying numbers as shown on loop sheets and Drawings. Brady markers, or equal, shall be used for this purpose.
 - e. A valved tee, in accordance with applicable specifications, shall be installed in the signal line from each field mounted pneumatic controller or transmitter for test and calibration of the instrument. Tubing shall be 3/8 inch - 304L SS - 0.035 minimum.

2. Tubing Fittings:

- a. All tubing connections shall be made with compression type fittings. Connections shall be made in strict accordance with manufacturer's recommendations.
- b. Threads of all fittings shall be wrapped with a single wrap of Teflon tape in place of doping.
- c. The tubing connection shall not be made prior to completing the make-up of the pipe connection. The tubing shall be checked for correct diameter and wall thickness. The tube ends shall be cut square and deburred. Care shall be taken during cutting to keep the tubing round. Fittings shall not be installed excessively close to a bend. A length of straight tube, not deformed by bending, is required for a proper connection. When a section of bent tubing is being connected, it shall be in proper alignment with the fittings. Springing the tube into position with the fittings will not be permitted. The tubing must be inserted into the fitting until firm contact is made with the seat of the fitting and tightened to manufacturer's specifications.

3. Tubing Supports: Single or double tubing runs shall be supported on 1-1/2 x 3/4 inch aluminum extruded channel. Channels shall be connected together by using flat stainless steel splice plates and stainless steel bolts and nuts. Tubing shall be stretched and laid in the support in neat straight parallel lines. Tubing and cable shall be firmly attached to the support at intervals not exceeding 4 feet. Tubing and cable support shall be sufficiently strong and adequately braced to carry the static load plus a safety margin to allow tubing to be worked in the support. Where supports must be supported from equipment, care shall be taken to prevent vibration and/or expansion from temperature changes. Supports shall be routed so that tubing or cable is accessible and protected from spills or mechanical damage. Support members shall be designed and installed so that they will not become a trough or trap. Vinyl coatings shall be resealed with "Plastisol", or approved equal, after cutting or welding.

Process Connections: Minimum tubing or piping size for process signal lines are to be 1/2 inch. If the instrument connection is different than 1/2 inch, reducing fittings shall be located at the instrument or panel. The first block valve for instrument connection shall be located as close as practicable to the process source. All piping and tubing assemblies shall be cleaned by disconnecting from equipment and blowing out with dry air prior to final assembly.

4. Tubing Tests: Before making final connections to instruments, all lines shall be tested as follows:

- a. Lines Connecting with Process or Utility Piping: Test at same pressure and length of time as main piping.
- b. Instrument Air Supply Piping: Test with dry air at 100 psig for 20 minutes.
- c. Pneumatic Lines: Test in accordance with ISA Standards, RP-71.

5. After final connections are made to instruments, these joints shall be checked for leaks at the maximum operating pressure of the instrument.
- E. Grooved Mechanical Joints
1. Grooves shall be prepared according to the coupling manufacturer's instructions.
 2. Grooved fittings, couplings, and grooving tools shall be the products of the same manufacturer.
 3. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer.
 4. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded.
- F. Sequences of Operation: Study the operation and sequence of local equipment controls, as a part of the conditions report, and note any deviations from the described sequences of operation on the contract drawings. Perform necessary adjustments to make the equipment operate in an optimum manner and fully document changes made.

3.3 Installation of Equipment

- A. Install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.
- B. Conduit, Connectors, and Fittings: All conduit, connectors, and fittings shall be in accordance with the requirements of Division 26.
- C. Control Panels: Control panels shall be located as indicated on the drawings. Devices located in the control panels shall be as shown on the drawings or as needed to provide the indicated control sequences. Care shall be taken to prevent damage to the panels by area construction. Panels shall be covered for protection should painting or sand blasting be required in the area.
- D. Instrument Shelters: Instrument shelters shall be installed in the location shown with the bottom 4.0 feet above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented with door facing North. Instruments located in shelters shall be mounted in the 3-dimensional center of the open space of the shelter.
- E. Electric Power Devices:
1. Potential and Current Transformers: Install potential and current transformers in enclosures unless otherwise shown. Current transformer leads shall be shorted when they are not connected to the measurement circuits.

2. Hour Meters: Meters shall be located in the control panel or as otherwise shown. Power to the meter shall be connected to the motor starter auxiliary contacts for pumps, blowers and other motor driven devices. For devices without motor starters, the meter shall be connected in parallel with the load. Where the meter voltage differs from the metered devices voltage, transformer shall be provided as necessary.
 3. Current Sensing Relays and Current Transducers for Motors: When used to sense meter/fan/pump status, current sensing relays shall be used for applications under 5 hp. Applications over 5 hp shall use a current transducer.
- F. Output Devices: Output devices (transducers, relays, contactors, or other devices) which are not an integral part of the control panel, shall be mounted in an enclosure mounted adjacent to the control panel, unless otherwise shown. Where H-O-A and/or override switches on the drawings or required by the control sequence, the switches shall be installed so that the control system controls the function through the automatic position and other controls work through the hand position.
- G. Enclosures: All enclosure penetrations shall be from the bottom of the enclosure and shall be sealed to preclude entry of water using a silicone rubber sealant.
- H. Transformers:
1. Transformers for control voltages below 120 V ac shall be fed from the nearest power panel or motor control center, using circuits provided for the purpose.
 2. Provide a disconnect switch on the primary side and a fuse on the secondary side.
 3. Transformers shall be enclosed in a steel cabinet with conduit connections.

3.4 Wire, Cable and Connecting Hardware

- A. All wiring shall be in accordance with the requirements of Division 26 and the following.
- B. Metering and Sensor Wiring: Metering and sensor wiring shall be installed in accordance with the requirements of ANSI C12.1, NFPA 70.
- C. Power Line Surge Protection: Control panels shall be protected from power line surges. Protection shall meet the requirements of IEEE C62.41.1 and IEEE C62.41.2. Fuses shall not be used for surge protection.
- D. Sensor and Control Wiring Surge Protection:
1. Digital and analog inputs shall be protected against surges induced on control and sensor wiring. Protect digital and analog outputs against surges induced on control and sensor wiring installed outdoors and as shown.
 2. Fuses shall not be used for surge protection.

3. Test the inputs and outputs in both the normal and common mode using the following two waveforms:
 - a. The first waveform shall be 10 microseconds by 1000 microseconds with a peak voltage of 1500 volts and a peak current of 60 amperes.
 - b. The second waveform shall be 8 microseconds by 20 microseconds with a peak voltage of 1000 volts and a peak current of 500 amperes.
4. Submit certified test results for surge protection.

3.5 Software Installation

- A. Load software required for an operational control system, including databases (for points specified and shown), operational parameters, and system, command, and application programs.
- B. Adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables.

3.6 Control Drawings

- A. Control drawings, framed, non-fading half-size in laminated plastic shall be provided for equipment furnished and for interfaces to equipment at each respective equipment location.
- B. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system manually shall be prepared in typed form and posted beside the diagrams.
- C. Diagrams and instructions shall be submitted prior to posting.
- D. The framed instructions shall be posted before acceptance testing of the system.

3.7 Field Testing and Adjusting Equipment

- A. Provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Engineer and Owner will witness the PVT, and written permission shall be obtained from the Engineer before proceeding with the testing.
- B. Original copies of data produced, including results of each test procedure, during PVT shall be turned over to the Owner at the conclusion of each phase of testing prior to Owner approval of the test.
- C. The test procedures shall cover actual equipment and functions specified for the project.

D. Endurance Test

1. Use the endurance test to demonstrate the overall system reliability of the completed system. The endurance test shall be conducted in phases.
2. The endurance test shall not be started until the Engineer notifies the Contractor in writing that the PVT is satisfactorily completed, training as specified has been completed, outstanding deficiencies have been satisfactorily corrected, and that the Contractor has permission to start the endurance test.
3. Provide an operator to man the system 8 hours per day during daytime operations, including weekends and holidays, during Phase I endurance testing, in addition to any Owner's personnel that may be made available.
4. The Owner may terminate testing at any time when the system fails to perform as specified.
5. Upon termination of testing by the Owner or by the Contractor, commence an assessment period as described for Phase II.
6. Upon successful completion of the endurance test, deliver test reports and other documentation, as specified, to the Owner prior to acceptance of the system.

3.8 Manufacturers' Field Services

- A. Obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified.
- B. The representative shall supervise the installing, adjusting, and testing of the equipment.

END OF SECTION



CONTROL NARRATIVE LOOPERS WASTEWATER TREATMENT PLANT DEWATERING FACILITY UPGRADES

Prepared
For: Dalton Utilities

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1.0 INTRODUCTION

This document is intended to describe the general operation and control of the equipment provided as part of the Dewatering Facility Upgrades. The Control Narrative shall be used in conjunction with Process Control Specification 40 60 00 and the Process and Instrumentation Diagrams (P&IDs).

General Arrangement Drawings, Control Sequences and P&IDs prepared by Flottweg Separation Technology and Spirac, Inc. are included as part of the Contract Documents. The Flottweg system provides for monitoring and control of Centrifuges #1 and #2, the existing polymer feed pumps #1 and #2, the existing sludge feed pumps #1 & #2, and initiates a system start to Spirac's conveyor system. Spirac's system provides for monitoring and control of the discharge conveyors and slide gates. Integration of the Flottweg and Spirac control systems with the plant control and SCADA system is included in the SCADA system allowance.

The Dewatering Facilities Upgrade Project includes replacement of the existing SLC 5/04 PLCs in existing Panels MCP 0101, MCP 0102, and MCP 0103, the existing DH+ backbone, modifying existing LCMR000 Dewatering Foxboro Panel, and a new Central Station Remote PC at the existing facility as well as IO upgrades for the centrifuge system.

2.0 PLANT CONTROL SYSTEM

2.1 Existing SCADA System

The Loopers Wastewater Treatment plant utilizes a Foxboro I/A Distributed Control System architecture with a combination of local programmable logic controllers (PLCs) and local dedicated Human Machine Interfaces (HMIs) for certain unit processes networked to the Foxboro Supervisory Control and Data Acquisition (SCADA) system for local and remote control, data logging and display.

2.2 SCADA System Modifications

The Dewatering Facility Upgrades require replacing the existing Allen Bradley SLC 5/04 PLCs with Modicon M340 PLCs and interfacing with the existing SLC 5/04 input/output modules that will remain. New communication and control equipment shall be supplied to interface with the new Centrifuges, Polymer Makeup Units, and Conveyor system.

The Dewatering Facility I-O and HMI will communicate to the Foxboro I/A System by the existing plant local area SCADA network. All existing systems affected by the upgrades including, but not limited to, the Thickener RTU and Sludge Prep RTU shall be updated, and new graphics, alarms, and data archiving updated to reflect the new work.

3.0 DEWATERING FACILITY

3.1 Associated Equipment

Table 3.1 – Dewatering Facility

Equipment Tag	Description
PY-P-8500, 8501	New Polymer Makeup Units #1 and #2
LS-8500, 8501	Existing Polymer Tank
PY-P-8510, PY-P-8520	Existing Polymer Feed Pumps #1 and #2
SL-CNTFG-8510, SL-CNTFG-8520	New Centrifuges #1 and #2
SL-CONV-8510, SL-CONV-8511, SL-CONV-8512, SL-CONV-8520, SL-CONV-8530, SG-8513, SG-8521, SG-8522, SG-8531, SG-8532	New Conveyor System

3.1.1 Associated P&IDs

See 03-DI001, 03-DI002, 03-DI003, 03-DI004, 03-DI8501, 03-DI8502, 03-DI8503, 03-DI8504

3.1.2 New Polymer Makeup Unit

The Polymer Makeup Units are furnished as a skid-mounted unit and includes all necessary piping, pumps, and control panels.

Pumps are equipped with LOCAL and REMOTE control. Pump Drives are normally operated in “LOCAL”. When pump drives are in “LOCAL”, the pumps start and mixes water (NPW) with neat polymer to fill the existing polymer solution tank. The speed of each pump is controlled from a local pot to maintain a mix ratio. The pump stops on a high level in the polymer solution tank.

The Polymer Makeup Unit does not interface with the SCADA system.

3.1.3 Existing Polymer Solution Tank

The Existing Polymer Solution Tank (3,000 gallon) stores the mixed polymer solution.

A “LOW” level in the tank will shut off the Centrifuges.

A “HIGH” level in the tank will shut off the Polymer Makeup Unit.

The Polymer Solution Tank does not interface with the SCADA System.

3.1.4 Existing Polymer Feed Pumps

Existing Polymer Feed Pumps are equipped with Variable Frequency Drives (VFD). The VFD controlled pumps are programmed to operate over a wide range of flows. The pumps direct polymer flow from the polymer solution tank to the centrifuge. All existing functionality of the pump controls shall remain and repurposed to the new Centrifuge Control Panels.

Pumps are equipped with LOCAL and REMOTE control. Pump Drives are normally operated in “REMOTE”. When pump drives are in “REMOTE”, a Polymer Pumping mode scheme is selected

by the operator via the Centrifuge HMI. The speed of the Pumps is controlled to maintain a TSS setpoint in the sludge feed at the input to the Centrifuge.

The operator is also able to select manual at the Centrifuge HMI and start / stop and adjust the pump speed. Each pump can be placed in LOCAL at the drive to manually start and stop and adjust speed during maintenance activities.

3.1.5 New Centrifuges #1 and #2

The Centrifuges and supporting equipment are furnished by Flottweg Separation System. Refer to the Flottweg documents for operation and control. The new centrifuges are replacing existing centrifuges and the existing control system / interface shall remain.

The Centrifuges will be able to start and stop from the Owner's SCADA System.

The Centrifuges will include the following interlocks:

- Existing Polymer Tank – The Centrifuges will shut down on low level
- Existing Polymer Feed Pumps – The Centrifuges will start / stop / and control the speed of the polymer feed pump. If a pump fails, the Centrifuge will shut down.
- New Conveyor System – The Centrifuge will start the conveyor system and receive a ready signal when the conveyor system is ready.
- Existing Sludge Feed - The Centrifuges will start / stop / and control the speed of the sludge feed pumps (via Thickener RTU MCP 0103) located in the Thickener Building. If a pump fails, the Centrifuge will shut down.

3.1.6 New Conveyor System

A new conveyor system control panel is being furnished by Spirac, Inc. Refer to the Spirac documents for operation and control.

The new conveyor system will include a combination of reversible conveyors and slide gates to discharge the cake into 8 separate drop zones - 4 for Trailer 1 and 4 for Trailer 2. The Owner's SCADA system will determine which drop zone via the following selectable matrix:

	SL-CONV-8510	SL-CONV-8511	SL-CONV-8512	SG-8513	SL-CONV-8520	SG-8521	SG-8522	SL-CONV-8530	SG-8531	SG-8532
TRAILER 1										
ZONE 1	RUN	RUN	RUN	OPEN	REV	CLOSED	OPEN	STOP	OPEN	OPEN
ZONE 2	RUN	RUN	RUN	OPEN	REV	OPEN	OPEN	STOP	OPEN	OPEN
ZONE 3	RUN	RUN	RUN	OPEN	FOR	OPEN	OPEN	STOP	OPEN	OPEN
ZONE 4	RUN	RUN	RUN	OPEN	FOR	OPEN	CLOSED	STOP	OPEN	OPEN
TRAILER 2										
ZONE 1	RUN	RUN	RUN	CLOSED	STOP	OPEN	OPEN	REV	CLOSED	OPEN
ZONE 2	RUN	RUN	RUN	CLOSED	STOP	OPEN	OPEN	REV	OPEN	OPEN
ZONE 3	RUN	RUN	RUN	CLOSED	STOP	OPEN	OPEN	FOR	OPEN	OPEN
ZONE 4	RUN	RUN	RUN	CLOSED	STOP	OPEN	OPEN	FOR	OPEN	CLOSED

