CONTRACT DOCUMENTS AND TECHNICAL SPECIFICATIONS

FOR

KIAWAH RIVER PLANTATION WASTEWATER TREATMENT PLANT

JOHNS ISLAND
CHARLESTON COUNTY, SC

PREPARED FOR
KIAWAH RIVER PLANTATION HOLDINGS, LP
AND OCEAN BOULEVARD PROPERTIES
A SOUTH CAROLINA LIMITED PARTNERSHIP

AUGUST 2015
ISSUED FOR BID JANUARY 29, 2016

J – 25328

Prepared by:

THOMAS & HUTTON

www.thomasandhutton.com

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INVITATION TO BID
Legal Notice

1. Sealed proposals for the **Kiawah River Plantation Wastewater Treatment (WWTP)** on Johns Island in Charleston County, SC owned by the **KIAWAH RIVER PLANTATION HOLDINGS, LP AND OCEAN BOULEVARD PROPERTIES A SOUTH CAROLINA LIMITED PARTNERSHIP** will be received by Thomas & Hutton at 682 Johnnie Dodd's Boulevard, Suite 100 until 2:30 P.M., Wednesday, March 16, 2016 at which time they will be privately opened.

2. The Kiawah River Plantation Wastewater Treatment Plant Project (0.11 mgd capacity expandable to 0.22 mgd) consists of the following components:
   - Headwork facility, including mechanical screening and odor control.
   - Anoxic/Pre-aeration and membrane thickening basins (25' X 38') including submersible mixers, diffused aeration system, blowers, and recycle pumps.
   - Membrane Bioreactor (MBR) basins (10' X 38') and covered equipment area on piles.
   - A two-story Building (1,995 SF total) on piles to provide the following:
     - Blowers, pumps and other equipment.
     - Equipment Support Room.
     - Storage and feed for sodium hypochlorite, sodium hydroxide, caustic soda, etc.
     - Control Room, associated casework and equipment.
     - Electrical/MCC Room, associated equipment.
     - Mechanical Room, associated equipment.
     - Storage Area.
     - Restroom with shower.
   - Monorail beam and hoist system for MBR filters.
   - Odor control facilities for the plant.
   - Screenings dumpster and slab for screening.
   - MBR filter wash pad on grade.
   - Dewatering (centrifuge) building (1,584 SF) and equipment.
   - Plant drain pump station.
   - Associated process and non–process yard piping.
   - Associated site pavement, grading and related.
   - One diesel engine generator with fuel tank, mechanical and electrical accessories.
   - Associated instrumentation and control equipment.
   - Associated communications system including Programmable Logic Controller (PLC), Input/Output (I/O) modules and Scada.
   - Associated electrical equipment and work.
   - Associated grounding and lightning protection systems.
   - Site and facility lighting.
   - Effluent holding basin and effluent pump station with fencing.
   - Land application system (piping, spray heads, control valves, etc.) with fencing.
   - Water supply piping & related.
   - Plant fencing and landscape buffers/plants.

3. *Bid bonds or certified cashier's check are not required*. Performance and Payment Bonds, each in an amount equal to 100% of the contract price shall be required of the successful bidder if contract is awarded. Each Bond shall be accompanied by a "Power of Attorney" authorizing the attorney-in-fact to bind the surety and certified to include the date of the bond.

4. Owner reserves the right to reject any or all Bids, including without limitation, the rights to reject any or all nonconforming, nonresponsive, unbalanced, or conditional Bids and to reject the Bid of any Bidder if Owner believes it would not be in the best interest of the Project to make an award to Bidder, whether because the Bid is not responsive or the Bidder is unqualified or of doubtful financial ability or fails to meet any other pertinent standard or criteria established by the Owner.

5. A Mandatory Pre-Bid Conference will be held on Wednesday February 17, 2016 at 2:00 P.M. in the offices of Thomas and Hutton at 682 Johnnie Dodds Blvd, Suite 100, Mt. Pleasant, SC 29464. All prospective bidders required to attend.

KIAWAH RIVER PLANTATION HOLDINGS, LP AND OCEAN BOULEVARD PROPERTIES A SOUTH CAROLINA LIMITED PARTNERSHIP

END OF INVITATION TO BID

DOCUMENT 00 21 13

INSTRUCTIONS TO BIDDERS

INTENTION: It is intended the Instructions to Bidders, General Conditions, Supplementary Conditions, Technical Specifications, and Construction Drawings shall cover the complete work to which they relate.

ARTICLE 1 **DEFINED TERMS**: In addition to the terms defined in the General Conditions, Section 00 72 43, (EJCDC C–700) (2007), additional terms used in these Instructions to Bidders have the meanings indicated below which are applicable to both the singular and plural thereof.

1.1. **Bidder** – One who submits a Bid directly to Owner as distinct from a sub–bidder, who submits a bid to a Bidder.

1.2. **Successful Bidder** – The lowest, responsible, and responsive Bidder to whom Owner (based on Owner's evaluation as hereinafter provided) makes an award.

1.3. **Bid** – A complete and properly signed offer to execute work for the prices stipulated in Bid Form and submitted in accordance with the Bidding Documents.

1.4. **Addenda** – Graphic or written documents issued by Engineer prior to the opening of Bids issued to clarify, revise, add to, or delete information in the original bidding documents or in previous addenda.

ARTICLE 2 **BID FORM**: All Bids must be made upon the Bid Forms hereto annexed, and shall state the amount bid for each item shown, and all bids must be for materials and work called for in the specifications. Any deposits for plans and specifications are not refundable.

2.1 The Bid Form is included with the Bidding Documents; additional copies may be obtained from Engineer.

2.2 All blanks on the Bid Form must be completed by printing in black ink or by typewriter.

2.3 Bids by corporations must be executed in the corporate name by the president or a vice–president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation must be shown below the signature.

2.4 All names must be typed or printed in blue ink below the signature.

2.5 The Bid shall contain an acknowledgment of receipt of all Addenda (the numbers of which must be filled in on the Bid Form.)

2.6 The address and telephone number for communications regarding the Bid must be shown.

ARTICLE 3 QUALIFICATIONS OF BIDDERS:

3.1 To demonstrate qualifications to perform the Work, each Bidder may be required to submit within five days after Bid opening, upon Owner's request, detailed written evidence such as financial data, previous experience, present commitments, and other such data as may be necessary to assist Owner in determining the Contractor's subcontractors qualifications.

3.2 Each Bid must contain evidence of Contractor's authority to conduct business in the state where the Work is to be performed. State Contractor license number, if applicable, must also be shown on the Bid Form.

ARTICLE 4 COPIES OF BIDDING DOCUMENTS:

4.1 Complete sets of Bidding Documents must be used in preparing Bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

4.2 Owner and Engineer, in making copies of Bidding Documents available for a non–refundable deposit, do so only for the purpose of obtaining Bids for the Work and do not confer a license or grant for any other use.

ARTICLE 5 EXAMINATION OF BIDDING DOCUMENTS, OTHER DATA, AND SITE:

5.1 The following items are the responsibility of each Bidder prior to submitting a bid:

5.1.1 To examine and study thoroughly the Bidding Documents and other related data identified in the Bidding Documents;

5.1.2 To visit the work site to ascertain, by inspection, pertinent local conditions such as location, character and accessibility of the site including existing surface and subsurface conditions in the work area; availability of facilities, location, and character of existing work within or adjacent thereto, labor conditions, etc.

5.1.3 To become familiar with and satisfy Bidder as to all federal, state, and local Laws and Regulations that may affect cost, progress, or performance of the Work;

5.1.4 To obtain and carefully study (or assume responsibility for doing so) all additional or supplementary investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities), at or contiguous to the Site, which:

5.1.4.1 May affect cost, progress, or performance of the Work.

5.1.4.2 Relate any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including those identified in the bidding documents, associated safety precautions and programs incident thereto.

5.1.5 To study and carefully correlate Bidder's knowledge and observations with the Bidding Documents and such other related data; and

5.1.6 To promptly notify Engineer of all conflicts, errors, ambiguities or discrepancies which Bidder has discovered in or between the Bidding Documents and such other related documents;

5.1.7 to agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies or data are necessary for the determination of its Bid for performance of the Work at the price bid and within the times and in accordance with the other terms and conditions of the Bidding Documents;

5.1.8 To become aware of the general nature of the work to be performed by OWNER and others at the Site that relates to the Work as indicated in the Bidding Documents;

5.1.9 To determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.

5.2 The Owner shall make available to all prospective bidders, previous to receipt of bids, information that it may have regarding subsurface conditions and surface topography at the work site. Such information shall be given as the best factual information available without being considered as a representation of the Owner.

5.3 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 5, that without exception, the Bid is premised upon performing and furnishing the Work required by the Bidding Documents and applying any specific means, methods, techniques, sequences, and procedures of construction that may be shown or indicated or expressly required by the Bidding Documents, that Bidder has given ENGINEER written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents and the written resolutions thereof by ENGINEER are acceptable to Bidder, and that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work.

ARTICLE 6 PRE–BID CONFERENCE:

A Mandatory Pre-Bid Conference will be held on Wednesday February 17, 2016 at 2:00 P.M. in the offices of Thomas and Hutton at 682 Johnnie Dodds Blvd, Suite 100, Mt. Pleasant, SC 29464. All prospective bidders required to attend.

ARTICLE 7 INTERPRETATIONS AND ADDENDA:

7.1 All questions about the meaning or intent of the Bidding Documents are to be directed to Engineer. The person submitting the request shall do so in writing and be responsible for its prompt delivery. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda, mailed or delivered to all parties recorded by Engineer as having received the Bidding Documents. Questions received less than ten working days prior to the date for opening of Bids may not be answered. Only questions answered by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

7.2 Addenda may also be issued to modify the Bidding Documents as deemed advisable by Owner or Engineer.

ARTICLE 8 BID SECURITY:
A bid bond is not required.

ARTICLE 9 CONTRACT COMPLETION TIME: The number of days within which, or by which the Work is to be (a) Substantially Completed and (b) also completed and ready for final payment are set forth in the Agreement. Provisions for liquidated damages, if any, are set forth in the Agreement.

ARTICLE 10 SUBSTITUTE AND "OR–EQUAL" ITEMS:

10.1 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, or those substitute or "or–equal" materials and equipment approved by ENGINEER and identified by Addendum. The materials and equipment described in the Bidding Documents establish a standard of required type, function and quality to be met by any proposed substitute or "or equal" item. No item of material or equipment will be considered by ENGINEER as a substitute or "or equal" unless written request for approval has been submitted by Bidder and has been received by ENGINEER at least 15 days prior to the date for receipt of Bids. The burden of proof of the merit of the proposed item is upon Bidder. ENGINEER's decision of approval or disapproval of a proposed item will be final. If ENGINEER approves any proposed item, such approval will be set forth in an Addendum issued to all prospective Bidders. Bidders shall not rely upon approvals made in any other manner.

ARTICLE 11 SUBCONTRACTORS, SUPPLIERS, AND OTHERS:

11.1 Each bid must be accompanied by a list of Subcontractors, Suppliers, individuals, or entities proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, individual, or entity. If OWNER or ENGINEER, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, OWNER or ENGINEER may, before the Notice of Award is given, request apparent Successful Bidder to submit a

substitute, in which case apparent Successful Bidder shall submit an acceptable substitute, Bidder's Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and OWNER may consider such price adjustment in evaluating Bids and making the contract award.

11.2 If apparent Successful Bidder declines to make any such substitution, OWNER may award the Contact to the next lowest Bidder proposing to use acceptable Subcontractors, Suppliers, individuals, or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed, and against which OWNER or ENGINEER makes no written objection prior to the giving of the Notice of Award, will be deemed acceptable to OWNER and ENGINEER subject to revocation of such acceptance after the Effective Date of the Agreement.

11.3 CONTRACTOR shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom CONTRACTOR has reasonable objection.

ARTICLE 12 **SUBMITTAL OF BIDS:** Bids shall be submitted at the time and place indicated in the Invitation to Bid and shall be enclosed in a sealed opaque envelope, marked with the project title, and name and address of Bidder, and accompanied by the Bid security and other required documents. If the Bid is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face of it. Contractor license number(s) shall be written on the face of the bid envelope.

Each Bidder is responsible for seeing their Bid is received by the Owner not later than the advertised time set for the opening of Bids.

ARTICLE 13 **MODIFICATION AND WITHDRAWAL OF BIDS**:

13.1 Bids may be modified or withdrawn by an appropriate document duly executed (in the manner a Bid must be executed) and delivered to the place where Bids are to be submitted at any time prior to the opening of bids.

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

ARTICLE 14 **OPENING OF BIDS:** Bids will be opened (unless obviously non–responsive) privately at the place where Bids are to be submitted. An abstract of the amount of the base Bids and major alternates (if any) may be made available to Bidders after the opening of Bids.

ARTICLE 15 **ACCEPTANCE OF BIDS:** Bids may not be withdrawn (except as noted in Paragraph 13) after the time set for the opening of Bids. Bids will remain subject

to acceptance for 150 days after the day of the Bid opening, but the Owner may, in its sole discretion, release any Bid and return the Bid security prior to expiration of the acceptance period.

ARTICLE 16 AWARD OF CONTRACT:

16.1 Owner reserves the right to reject any or all Bids, including without limitation, the rights to reject any or all nonconforming, nonresponsive, unbalanced or conditional Bids and to reject the Bid of any Bidder if Owner believes it would not be in the best interest of the Project to make an award to a Bidder, whether because the Bid is not responsive, or the Bidder is unqualified or of doubtful financial ability, or fails to meet any other pertinent standard or criteria established by the Owner.

16.2 Owner also reserves the right to waive all informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum. Discrepancies between words and figures will be resolved in favor of the words.

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

The Owner will also consider whether the Bidder involved:

a) Maintains a permanent place of business;
b) Has adequate plant and equipment to do the work properly and expeditiously;
c) Has suitable financial status to meet obligations incidental to the work;
d) Has appropriate technical experience.
e) Has completed similar projects.
f) Meets the owner's development and financial goals.
g) Meets the owner's development schedule.

16.4. Owner may consider the qualifications and experience of Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work as to which the identity of Subcontractors, Suppliers, and other persons and organizations must be submitted as provided in the Supplementary Conditions. Owner also may consider the operating costs, maintenance requirements, performance data and guarantees of major items of materials and equipment proposed for incorporation in the Work when such data is required to be submitted prior to the Notice of Award.

16.5. Owner may conduct such investigations as Owner deems necessary to assist in the evaluation of any bid and to establish the responsibility, qualifications and financial ability of Bidders, proposed Subcontractors,

Suppliers and other persons and organizations to perform and furnish the Work in accordance with the Contract Documents to Owner's satisfaction within the prescribed time.

16.6. If the contract is to be awarded, it will be awarded based upon the base bid amount and to the Bidder whose evaluation by Owner indicates the award will be in the best interest of the Project.

16.7. If the contract is to be awarded, Owner will give Successful Bidder a Notice of Award within 150 days after the day of the Bid opening.

ARTICLE 17 **MODIFICATIONS OF QUANTITIES:** If the lowest bona fide Bid exceeds the money available for the Work, the Owner reserves the right to delete enough of the Work to bring the cost within the available funds. The Owner also reserves the right to delete whichever items or portions of items considered to be in the best interest of the Owner.

ARTICLE 18 **CONTRACT SECURITY:** The General Conditions and Supplementary Conditions set forth Owner's requirements as to performance and payment bonds. When the Successful Bidder delivers the executed Agreement to the Owner, it must be accompanied by the required performance and payment bonds.

ARTICLE 19 **SIGNING THE AGREEMENT:** When the Owner gives a Notice of Award to the Successful Bidder, it will be accompanied by the required number of unsigned counterparts of the Agreement with all other written Contract Documents attached. Within 20 days thereafter, Contractor shall sign and deliver the required counterparts of the Agreement and attached documents to Owner with the required Bonds. Within 15 days thereafter, Owner shall deliver one fully signed counterpart to Contractor.

ARTICLE 20 **LAWS AND REGULATIONS:** The Contractor shall comply with local, District, County, State, and Federal laws applicable to the work.

The Contractor shall comply with the Department of Labor Safety and Health Regulations for Construction promulgated under the Occupational Safety and Health Act of 1970, as amended through January 1, 2004 (PL 91–596), and under Section 107 of the Contract Work and Safety Standards Act (PL) 91–54). The regulations are administered by the Department of Labor and the Contractor shall allow access to the project to personnel from this Department.

ARTICLE 21 **CONTRACTOR'S AND SUBCONTRACTOR'S INSURANCE:** Contractor shall not commence work under this contract until obtaining all the insurance required by the Supplementary Conditions.

ARTICLE 22 **TERMINATION OF CONTRACT:** If the Owner is made to stop construction of the work because of an order from a Court or State Department, the contract shall be terminated. Payment will be made for work completed and a proration of the work underway, materials stored, and for the overhead and profit of the completed work and work underway. Payment will not be made for anticipated profit and overhead on work not completed or underway.

END OF SECTION

DOCUMENT 00 41 43

BID FORM

PROJECT IDENTIFICATION:
Kiawah River Plantation (KRP) Wastewater Treatment Plant (WWTP)

CONTRACT IDENTIFICATION AND NUMBER:
J – 25328

THIS BID IS SUBMITTED TO:
Kiawah River Plantation Holdings, LP
and Ocean Boulevard Properties
a South Carolina Limited Partnership

C/O of Thomas & Hutton Engineering Co.
682 Johnnie Dodds Boulevard, Suite 100
Mt. Pleasant, SC 29464

1. The undersigned BIDDER proposes and agrees, if this Bid is accepted, to enter into an agreement with OWNER in the form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Bid Price and within the Bid Times indicated in this Bid and in accordance with the other terms and conditions of the Contract Documents.

2. BIDDER accepts all of the terms and conditions of the Advertisement or Invitation to Bid and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 150 days after the day of Bid opening, or for such longer period of time BIDDER may agree to in writing upon request of OWNER.

3. In submitting this Bid, BIDDER represents, as more fully set forth in the Agreement, that:

   a. BIDDER has examined and carefully studied the Plans and Specifications for the work and contractual documents relative thereto, and has read all Technical Provisions, Supplementary Conditions, and General Conditions, furnished prior to the opening of Bids and can fulfill the requirements of the work to be performed.

   b. BIDDER further acknowledges hereby receipt of the following Addenda:

ADDENDUM NO.	DATE

   c. BIDDER has visited the site and become familiar with and is satisfied as to the general, local and site conditions possibly affecting cost, progress, performance

and furnishing of the Work;

d. BIDDER is familiar with and is satisfied as to all federal, state, and local Laws and Regulations possibly affecting cost, progress, performance and furnishing of the Work.

e. BIDDER has carefully studied all reports of explorations and tests of subsurface conditions, at or contiguous to the site, and all drawings of physical conditions in or relating to existing surface or subsurface structure, at or contiguous to the site (except underground Facilities), have been identified in the Supplementary Conditions. BIDDER acknowledges such reports and drawings are not Contract Documents and may not be complete for BIDDER's purposes.

   BIDDER acknowledges OWNER and Engineer do not assume responsibility for the accuracy or completeness of information and data shown or indicated in the Bidding Documents with respect to Underground Facilities, at or contiguous to the site. BIDDER has obtained and carefully studied (or assumes responsibility for having done so) all such additional or supplementary investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities), at or contiguous to the site or otherwise, or which relate any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including those identified in the bidding documents, associated safety precautions and programs incident thereto.

   BIDDER does not consider any additional examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance and furnishing of the Work in accordance with the times, price and other terms and conditions of the Bidding Documents.

f. BIDDER is aware of the general nature of Work to be performed by Owner and others at the site relating to Work for which this Bid is submitted as indicated in the Bidding Documents.

g. BIDDER has correlated the information known to BIDDER, information and observations obtained from visits to the site, reports and drawings identified in the Bidding Documents and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents.

h. BIDDER has given ENGINEER written notice of all conflicts, errors, ambiguities, or discrepancies BIDDER has discovered in the Bidding Documents and the written resolution thereof by ENGINEER is acceptable to BIDDER. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work for which this Bid is submitted.

i. This bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm, or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; BIDDER has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; BIDDER has not solicited or induced any person, firm or corporation to refrain from bidding; and BIDDER has not sought by collusion to obtain for itself any advantage over any other Bidder or over OWNER.

j. Bidder has fully coordinated with the MBR supplier, Ovivo, and has included in the base bid price all work, materials, labor, equipment, and related to provide a

complete and fully functional plant including the MBR system.

4. BIDDER will complete the Work in accordance with the Contract Documents for the prices should on bid form exhibit A. The total contract price shall include the allowances specified in Section 01 21 00 and shall include all costs related to the MBR system.

BASE BID
See Bid Form Exhibit A for Unit Pricing

TOTAL BASE BID PRICE:_____

_____
(Use words)

($_____)
(Figures)

BID ALTERNATES - as indicated in the Bidding Documents and generally described as follows:

ALTERNATE #1 *(Brief Description)*:

☐ **ADD TO** or ☐ **DEDUCT FROM BASE BID:**_____

(Bidder to Mark appropriate box to clearly indicate the price adjustment offered for each alternate)

5. BIDDER agrees the Work will be substantially complete and ready for final payment in accordance with paragraph 14.07 of the General Conditions within 510 calendar days after the date when the Contract Times commence to run.

6. BIDDER accepts provisions of the Agreement as to liquidated damages, in the amount of $2,000 per day, in the event of failure to complete the Work within times specified in the Agreement.

7. The following documents are attached to and made a condition of this Bid:

   a. Tabulation of Subcontractors, Suppliers, and other persons and organizations required to be identified in this Bid.

   b. Add other documents as pertinent.

8. The undersigned further agrees in case of failure on his/her part to execute the said contract and the Bond within 15 consecutive calendar days after written notice being given of the award of the contract, the check or bid bond accompanying this bid, and the monies payable thereon shall be paid into the funds of the Owner as liquidated damages for such failure, otherwise, the check or bid bond accompanying this proposal shall be returned to the undersigned.

9. Communications concerning this Bid shall be addressed to:

Thomas & Hutton Engineering Co.
682 Johnnie Dodds Boulevard, Suite 100
Mt. Pleasant, SC 29464
Attn: Mark Yodice

10. Terms used in this Bid which are defined in the General Conditions or Instructions will have the meanings indicated in the General Conditions of Instructions.

SUBMITTED on _____, 2016.

_____
CONTRACTOR'S NAME

ADDRESS:

_____

_____

BY:_____

_____

State Contractor License No._____

State Bidder License No._____

State Utility Contractor License No. _____

Exhibit A - Bid Form

Kiawah River Plantation (KRP) WWTP-Phase 1
Charleston County, SC

BID FORM

DATE: Jan. 29, 2016	Revised

ITEM	DESCRIPTION	QUANTITY		COST	
		No. oF UNITS	UNIT OF MEASURE	PER UNIT	TOTAL COST
	BASE BID				
	Cost of any items shown on drawings and/or included in the specifications that are not on this bid form must be included with an associated bid item. The cost show for the "Total Project" will include all items required on the drawings and within the specifications. The "Total Project" bid shall be full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work including overhead and profit.				
1	Mobilization (Max allowable is 1.25% of total contract amount)	1	job	Lump Sum	
2	Project Insurance	1	job	Lump Sum	
3	Performance/Payment Bonds	1	job	Lump Sum	
4	Project Administration	1	job	Lump Sum	
5	Erosion Control	1	job	Lump Sum	
6	Demobilization & Final Clean up	1	job	Lump Sum	
7	Screen structure	1	job	Lump Sum	
8	Grit cats and piping	1	job	Lump Sum	
9	Reg U Flow and piping	1	job	Lump Sum	
10	Testing	1	job	Lump Sum	
11	Piles	1	job	Lump Sum	
12	Process Tank (Basins)	1	job	Lump Sum	
13	Building (Operation, Chlorine and Equipment Support)	1	job	Lump Sum	
14	HVAC	1	job	Lump Sum	
15	Plumbing	1	job	Lump Sum	
16	MBR Equipment (membranes, pumps, valves, meters, etc. including Primary & Secondary Screen w/Grit Removal - Bongo screens	1	job	Lump Sum	
17	MBR installation	1	job	Lump Sum	
18	Slide gates	1	job	Lump Sum	
19	Piping	1	job	Lump Sum	
20	Centrifuge Building including subgrade preparation	1	job	Lump Sum	
21	Centrifuge Building Structure	1	job	Lump Sum	
22	Centrifuge Equipment	1	job	Lump Sum	
23	Centrifuge & Plant Drain Pump Station Odor Control Unit, duct piping & related work	1	job	Lump Sum	
24	Centrifuge Liquid Polymer System	1	job	Lump Sum	
25	Centrifuge Building Electrical, Mechancial, Plumbing	1	job	Lump Sum	
26	Chlorine Contact Tank (basin structure) and subgrade preparation	1	job	Lump Sum	
27	Chlorine Contact Tank (equipment)	1	job	Lump Sum	
28	Odor Control Unit, Duct piping and related (for MBR Basins & Screens)	1	job	Lump Sum	
29	Disinfection System - Skid	1	job	Lump Sum	

Exhibit A - Bid Form

Kiawah River Plantation (KRP) WWTP-Phase 1
Charleston County, SC

BID FORM

DATE: Jan. 29, 2016	Revised

ITEM	DESCRIPTION	QUANTITY		COST	
		No. oF UNITS	UNIT OF MEASURE	PER UNIT	TOTAL COST
	BASE BID				
30	Disinfection System - Storage tanks	2	ea.		
31	Disinfection System - Misc. Equipment	1	job	Lump Sum	
32	Effluent Pond/Storage/Piping & Piping from WWTP	1	job	Lump Sum	
33	Effluent Pump Station	1	job	Lump Sum	
34	WWTP Site Fencing	1	job	Lump Sum	
35	Effluent Holding Pond Area Site Fencing	1	job	Lump Sum	
36	LAS Area Site Fencing	1	job	Lump Sum	
37	10-inch irrigation distribution main from effluent pump station to LAS Site Fencing	1	job	Lump Sum	
38	Site Lighting	1	job	Lump Sum	
39	Civil / Site	1	job	Lump Sum	
40	Electrical & I/C	1	job	Lump Sum	
41	Standby Generator	1	job	Lump Sum	
42	Generator support structure	1	job	Lump Sum	
43	Landscape	1	job	Lump Sum	
44	Equipment pads (odor control, HVAC, wash-down, etc.)	1	job	Lump Sum	
45	Plant drain pump station	1	job	Lump Sum	
46	Misc. Yard Piping including site water	1	job	Lump Sum	
47	Identifying devices	1	job	Lump Sum	
48	Coatings	1	job	Lump Sum	
49	Phase 1 LAS (land application system)	1	job	Lump Sum	
50	Scada	1	job	Lump Sum	
51	Utility relocation allowance	1	job	$ 10,000	$ 10,000
52	Contingency allowance	1	job	$ 30,000	$ 30,000
	SUBTOTAL				
A	12-inch water main to serve WWTP (fire & domestic). From connection to WWTP entry road	1	job	Lump Sum	
	TOTAL PROJECT				

SECTION 00 51 00

NOTICE OF AWARD

Dated _____

TO: _____
(Bidder)

ADDRESS: _____

_____

JOB NO.: J –25832

PROJECT: Kiawah River Plantation Wastewater Treatment Plant

CONTRACT FOR:

The Kiawah River Plantation Wastewater Treatment Plant Project consists of the following components:

1. Headwork facility, including mechanical screening and odor control.
2. Anoxic/Pre-aerations and membrane thickening basins including submersible mixers, diffused aeration system, blowers, and recycle pumps.
3. Membrane Bioreactor (MBR) basins and covered equipment area.
4. A two-story Building to provide the following:
    a. Blowers, pumps and other equipment.
    b. Equipment Support Room.
    c. Storage and feed for sodium hydrochlorite, sodium hydroxide, caustic soda, etc.
    d. Control Room, associated casework and equipment.
    e. Electrical/MCC Room, associated equipment.
    f. Mechanical Room, associated equipment.
    g. Storage Room.
    h. Restroom with shower.

5. Monorail beam and hoist system for MBR filters.
6. Odor control facilities for the plant.
7. Screenings dumpster and slab for screening.
8. MBR filter wash pad on grade.
9. Dewatering (centrifuge) building and equipment.
10. Plant drain pump station.
11. Associated process and non–process yard piping.
12. Associated site pavement, grading and related.
13. One diesel engine generator with fuel tank, mechanical and electrical accessories, and access walkway.
14. Associated instrumentation and control equipment.
15. Associated communications system including Programmable Logic Controller (PLC) and Input/Output (I/O) modules and Scada.
16. Associated electrical equipment and work.
17. Associated grounding and lightning protection systems.
18. Site and facility lighting.
19. Effluent holding basin, effluent pump station with fencing.
20. Chlorine contact basin.
21. Land application system (piping, control valves, spray heads & related) and fencing.
22. Water supply piping & related.
23. Fencing and landscape buffers/plants.

You are hereby notified that your Bid dated _____, 20___, for the above Project has been considered. You are the apparent successful bidder and have been awarded a contract for:

Kiawah River Plantation Trail Wastewater Treatment Facility

The Contract Price of your contract is:

_____Dollars

($_____)

_____ copies of each of the proposed Contract Documents (except drawings) accompany this Notice of Award.

_____ sets of the Drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within 15 days of this Notice of Award, which is by _____, 20____.

1. You must deliver to the OWNER ____ fully executed counterparts of the Agreement including all the Contract Documents. Each of the Contract Documents must bear your signature on the page (pages _____.)

2. You must deliver, with the executed Agreement, the Contract Security (Bonds) as specified in the Instructions to Bidders, Standard General Conditions and Supplementary Conditions.

3. (List other conditions precedent)

Failure to comply with these conditions within the time specified will entitle OWNER to consider your bid in default, to annul this Notice of Award and to declare your Bid Security forfeited.

Within ten days after you comply with the above conditions, OWNER will return to you one fully signed counterpart of the Agreement with the Contract Documents attached.

_____
Owner

By: _____

_____
(Title)

ACCEPTANCE OF AWARD

_____
Contractor

By: _____
(Authorized Signature)

_____
(Title)

_____
(Date)

DOCUMENT 00 52 43

AGREEMENT FORM

THIS AGREEMENT is dated as of the _____ day of _____ in the year 2016 by and between **Kiawah River Plantation Holdings, LP and Ocean Boulevard Properties a South Carolina Limited Partnership** (hereinafter called OWNER) and _____ (hereinafter called CONTRACTOR).

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE 1 WORK

CONTRACTOR shall complete all Work as specified or indicated in the Contract Documents and required to provide a fully functional and complete plant. A general description of the Work is provided in the General Requirements and as briefly listed below:

The Kiawah River Plantation Wastewater Treatment Plant Project consists of the following components:

- Headwork facility, including mechanical screening and odor control.
- Anoxic/Pre-aerations and membrane thickening basins including submersible mixers, diffused aeration system, blowers, and recycle pumps.
- Membrane Bioreactor (MBR) basins and covered equipment area.
- A two-story Building to provide the following:
    - Blowers, pumps and other equipment.
    - Equipment Support Room.
    - Storage and feed for sodium hydrochlorite, sodium hydroxide, caustic soda, etc.
    - Control Room, associated casework and equipment.
    - Electrical/MCC Room, associated equipment.
    - Mechanical Room, associated equipment.
    - Storage Room.
    - Restroom with shower.
- Monorail beam and hoist system for MBR filters.
- Odor control facilities for the plant.
- Screenings dumpster and slab for screening.
- MBR filter wash pad on grade.
- Dewatering (centrifuge) building and equipment and building support.
- Plant drain pump station.
- Associated process and non–process yard piping.
- Associated site pavement, grading and related.
- One diesel engine generator with fuel tank, mechanical and electrical accessories, and access walkway.
- Associated instrumentation and control equipment.
- Associated communications system including Programmable Logic Controller (PLC) and Input/Output (I/O) modules and Scada.
- Associated electrical equipment and work.
- Associated grounding and lightning protection systems.
- Site and facility lighting.
- Effluent holding basin and effluent pump station with fencing.
- Chlorine contact basin.

- Land application system (piping, control valves, spray heads) and fencing.
- Water supply piping & related.
- Plant fencing and landscape buffers/plants.

ARTICLE 2 ENGINEER

The Project has been designed by Thomas & Hutton Engineering Co., who is hereinafter called ENGINEER, who is to act as OWNER's representative, assume all duties and responsibilities, and have the rights and authority assigned to ENGINEER in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

ARTICLE 3 CONTRACT TIMES

All time limits for Substantial Completion and completion and readiness for final payment as stated in the Contract Documents are of essence to the Contract.

3.1 The Work will be substantially completed within 510 days after the date when the Contract Times commence to run as provided in paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with paragraph 14.07 of the General Conditions within 540 days after the date when the Contract Times commence to run. Included in the contract times are 5 days per month for rain delay. Time delays due to rain in excess of the above days shall be reported by the Contractor to the Engineer in writing, within 30 days of each event.

3.2 *Liquidated Damages.* OWNER and CONTRACTOR recognize time is of the essence for this Agreement and OWNER will suffer financial loss if the Work is not completed within the times specified in paragraph 3.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving the actual loss suffered by OWNER if the Work is not substantially complete on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree to liquidated damages for delay (but not as a penalty) the CONTRACTOR shall pay OWNER Twenty Five hundred dollars ($2,000.00) for each day expiring after the time specified in paragraph 3.1 for Substantial Completion until the Work is substantially complete. After Substantial completion, if CONTRACTOR shall neglect, refuse or fail to complete the remaining Work within the time specified in paragraph 3.1 for completion and readiness for final payment or any proper extension thereof granted by OWNER, CONTRACTOR, shall pay OWNER One thousand dollars ($1,000.00) for each day expiring after the time specified in paragraph 3.1 for completion and readiness for final payment.

ARTICLE 4 CONTRACT PRICE

4.1 *UNIT PRICE WORK*

OWNER shall pay CONTRACTOR for completion of the Work in accordance with the Contract Documents an amount in current funds of the amounts determined for all Unit Price Work, an amount equal to the sum established in agreement exhibit A, said amount being:

_____(dollars) $_____
(use words) *(figures)*

ARTICLE 5 PAYMENT PROCEDURES

CONTRACTOR shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

5.1 *Progress Payments; Retainage*. OWNER shall make progress payments on account of the Contract Price on the basis of CONTRACTOR's Applications for Payment as recommended by ENGINEER, on or about the **25th** day of each month during performance of the Work as provided in paragraphs 5.1.1., 5.1.1.2. and 5.2. below. All such payments will be measured by the schedule of values established in paragraph 2.07 of the General Conditions (and in the case of Unit Price Work based on the number of units completed) as provided in the General Requirements.

5.1.1 *For Cost of Work:* Progress payments on account of the Cost of the Work will be made:

5.1.1.1 Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below, but, in each case, less the aggregate of payments previously made and less such amounts as ENGINEER shall determine, or OWNER may withhold, in accordance with paragraph 14.02 of the General Conditions.

90% of the Work completed (with the balance being retainage). If Work has been 50% completed as determined by ENGINEER, and if the character and progress of the Work have been satisfactory to OWNER and ENGINEER, OWNER, on recommendation of ENGINEER, may determine as long as the character and progress of the Work remain satisfactory to them, there will be no additional retainage on account of Work completed, in which case the remaining progress payments prior to Substantial Completion will be in an amount equal to 100% of the Work completed.

90% of Cost of the Work (with the balance being retainage) applicable to materials and equipment not incorporated in the Work (but delivered, suitably stored and accompanied by documentation satisfactory to OWNER as provided in paragraph 14.02.A.1 of the General Conditions).

5.1.1.2 Upon Substantial Completion, in an amount sufficient to increase the total payments to CONTRACTOR to **90%** of the Cost of the Work, (with the balance being retainage), less such amounts as ENGINEER shall determine, or OWNER may withhold, in accordance with paragraph 14.02 of the General Conditions.

5.2 *Final Payment.* Upon final completion and acceptance of the Work in accordance with paragraph 14.07 of the General Conditions, OWNER shall pay the remainder of the Contract Price as recommended by ENGINEER as provided in said paragraph 14.07.

ARTICLE 6 INTEREST

All moneys not paid within thirty days of the due date as provided in Article 14 of the General Conditions, shall bear interest at the rate of six percent annually or the minimum required by law at the place of the Project, whichever is greater.

ARTICLE 7 CONTRACTOR'S REPRESENTATIONS

In order to induce OWNER to enter into this Agreement CONTRACTOR makes the following representations:

7.1 CONTRACTOR has examined and carefully studied the Contract Documents (including the Addenda indicated in Article 8 hereinafter) and the other related data identified in the Bidding Documents.

7.2 CONTRACTOR has visited the site and become familiar with and is satisfied as to the general, local and site conditions possibly affecting cost, progress, performance, or furnishing of the Work.

7.3 CONTRACTOR is familiar with and is satisfied as to all federal, state, and local Laws and Regulations possibly affecting cost, progress, performance and furnishing of the Work.

7.4 CONTRACTOR has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in the General Conditions. CONTRACTOR acknowledges such reports and drawings are not Contract Documents and may not be complete for CONTRACTOR's purposes. CONTRACTOR acknowledges OWNER and ENGINEER do not assume responsibility for the accuracy or completeness of information and data shown or indicated in the Contract Documents with respect to Underground Facilities at or contiguous to the site. CONTRACTOR has obtained and carefully studied (or assumes responsibility for having done so) all such additional supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the construction to be employed by CONTRACTOR and safety precautions and programs incident thereto. CONTRACTOR does not consider any additional examinations, investigations, explorations, tests, studies, or data are necessary for

the performance and furnishing of the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the Contract Documents.

7.5 CONTRACTOR is aware of the general nature of work to be performed by OWNER and others at the site relating to the Work as indicated in the Contract Documents.

7.6 CONTRACTOR has correlated the information known to CONTRACTOR, information and observations obtained from visits to the site, reports and drawings identified in the Contract Documents and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

7.7 CONTRACTOR has given ENGINEER written notice of all conflicts, errors, ambiguities, or discrepancies CONTRACTOR has discovered in the Contract Documents and the written resolution thereof by ENGINEER is acceptable to CONTRACTOR, and the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 8 CONTRACT DOCUMENTS

The Contract Documents which comprise the entire agreement between OWNER and CONTRACTOR concerning the Work consist of the following:

8.1 Invitation to Bid (Pages 00 11 16–1 to 00 11 16–2, inclusive)

8.2 Instructions to Bidders (pages 00 21 13–1 to 00 21 13–7, inclusive)

8.3 Bid Form (pages 00 41 43–1 to 00 41 43–4, inclusive)

8.4 Notice of Award (pages 00 51 00–1 to pages 00 51 00–3, inclusive)

8.5 Agreement Form – (Single – Prime Contract) (pages 00 52 43–1 to 00 52 43–7, inclusive)

8.6 Notice to Proceed (pages 00 55 00–1 to 00 55 00–6, inclusive)

8.7 Performance Bond (pages 00 61 13.13–1 to 00 61 13.13–6. Inclusive)

8.8 Payment Bond (pages 00 61 13.16–1 to 00 61 13.16–, inclusive)

8.9 General Conditions (pages 00 72 43–1 to 00 72 43–62, inclusive)

8.10 Supplementary Conditions (pages 00 73 00–1 to 00 73 00–4, inclusive)

8.11 Special Conditions (pages 00 80 00–1 to 00 80 00–6, inclusive)

8.12 Closeout Procedures (pages 01 77 00–1 to 01 77 00–4, inclusive)

8.13 Bonds (pages 01 78 33–1 to 01 78 33–2, inclusive)

8.14 Warranties (pages 01 78 36–1 to 01 78 36–2, inclusive)

8.15 Technical Specifications consisting of the sections as listed in the Table of Contents.

8.16 Addenda numbers ____ to ____, inclusive.

Exhibits to this Agreement:

a. CONTRACTOR's Bid (page _____ through page _____ inclusive) marked "Exhibit _____."

b. Documentation submitted by CONTRACTOR prior to Notice of Award (pages ___ to ___, inclusive).

c. Any modification, including Change Orders, duly delivered after execution of Agreement.

There are no Contract Documents other than those listed above in this Article 8. The Contract Documents may only be amended, modified, or supplemented as provided in paragraph 3.04 of the General Conditions.

ARTICLE 9 MISCELLANEOUS

9.1 Terms used in this Agreement which are defined in Article 1 of the General Conditions will have the meanings indicated in the General Conditions.

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

9.3 OWNER and CONTRACTOR each binds itself, its partners, successors, assigns and legal representatives to the other party hereto, its partners, successors, assigns and legal representatives in respect to all covenants, agreements and obligations contained in the Contract Documents.

9.4 Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon OWNER and CONTRACTOR, who agree the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision coming as close as possible to expressing the intention of the stricken provision.

ARTICLE 10 OTHER PROVISIONS

For rain delays in excess of the five days per month, the Contractor shall be entitled to one day extension of time for each day in any given month that the actual rain days measured at the project exceeds the five days. In order to qualify as a rain day, there must be at least one-tenth of an inch (0.1") precipitation on the date in question. The Contractor shall maintain a rain gauge at the site and keep and document rain measurements at its own expense. The Contractor shall submit any requests for rain days by the tenth day of the following month. Rain and weather delay extensions of time are non-compensable delays and the contractor shall be entitled to no additional compensation as a consequence of rain or weather related extensions hereunder.

IN WITNESS WHEREOF, OWNER and CONTRACTOR have signed this Agreement in five counterparts. Two counterparts each have been delivered to OWNER and CONTRACTOR and one counterpart to ENGINEER. All portions of the Contract Documents have been signed, initialed or identified by Owner and Contractor or identified by ENGINEER on their behalf.

This Agreement will be effective on _____, 2016
(which is the Effective Date of the Agreement).

OWNER_____

BY *(typed)* _____

BY _____

ATTEST _____

Address for giving notices

_____

_____

_____

CORPORATE SEAL

BY *(typed)*_____

BY_____

ATTEST_____

Address for giving notices

_____

_____

_____

License No._____

Agent for service of process:_____

_____

CORPORATE SEAL

Section 00 55 00

NOTICE TO PROCEED

Dated: _____

TO: _____
(Bidder)

ADDRESS: _____

_____

JOB NO.: J –25328

PROJECT: Kiawah River Plantation Wastewater Treatment Plant

CONTRACT FOR: A general scope of work for this project is included in the Invitation to Bid.

You are hereby notified the Contract Times under the above contract will commence on _____, 2016. By such date, you are to start performing your obligations under the Contract Documents. In accordance with Article 3 of the Agreement the dates of Substantial Completion and completion and readiness for final payment are _____, 20__ and _____, 20__, respectively.

Before you may start any Work at the site, paragraph 2.01 of the General Conditions requires that you and OWNER must each deliver to the other (with copies to ENGINEER and other identified additional insureds) certificates of insurance, which each is required to purchase and maintain in accordance with the Contract Documents.

Before you may start any Work at the site, you must submit the following: Certificate of Insurance, Performance Bond, and Payment Bond.

_____
OWNER

By: _____

_____
(Title)

ACCEPTANCE OF NOTICE TO PROCEED

_____
CONTRACTOR

By: _____
(Authorized Signature)

_____
(Title)

_____
(Date)

DOCUMENT 00 61 13.13

PERFORMANCE BOND FORM

KNOW ALL MEN BY THESE PRESENTS,
hereinafter called "Principal" and _____,
(Name & Address of Surety)

_____ of _____

State of _____, hereinafter called the "Surety" are held and

firmly bound unto, **Kiawah River Plantation Holdings, LP and Ocean Boulevard Properties a South Carolina Limited Partnership** hereinafter called the "Owner" in

the penal sum of:

_____
(Contract Sum)

lawful money of the United States of America, to be paid to OWNER, for the payment whereof well and truly to be made we do bind ourselves, our respective executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the above bounden Principal has entered into a certain contract with the Owner dated the _____ day of _____, 20__ for the construction of:

Kiawah River Plantation Wastewater Treatment Plant (WWTP) on Johns Island, SC

Said contract is hereby incorporated by reference, and is hereinafter referred to as the Construction Contract.

NOW THEREFORE, THE CONDITION OF THIS OBLIGATION is such, if the Principal shall promptly and faithfully perform and comply with the terms and conditions of said contract; and shall indemnify and save harmless the Owner against and from all costs, expenses, damages, injury, or loss to which said Owner may be subjected by reason of any wrongdoing, including patent infringement, misconduct, want of care or skill, default, or failure of performance on the part of said Principal, its agents, subcontractors or employees, in the execution or performance of said Construction Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

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

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

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

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

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

   3.3 The Owner has agreed to pay the Balance of the Contract Price to the Surety in accordance with the terms of the Construction Contract or to a Contractor selected to perform the Construction Contract in accordance with the terms of the contract with the Owner.

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

   4.1 Arrange for the Contractor, with consent of the Owner, to perform and complete the Construction Contract; or

   4.2 Undertake to perform and complete the Construction Contract itself, through its agents or through independent Contractors; or

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

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

      4.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, tender payment therefor to the Owner; or

      4.4.2 Deny liability in whole or in part and notify the Owner citing reasons therefor.

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

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

    6.1 The responsibilities of the Contractor for correction of defective work and completion of the Construction Contract:

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

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

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

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

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

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

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

12. DEFINITIONS:

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

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

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

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

IN WITNESS WHEREOF, this instrument is executed in three (3) counterparts, each one of which shall be deemed an original, on this the ___ day of _____.

CONTRACTOR AS PRINCIPAL:

_____
Principal

_____
(Principal) Secretary

By:_____
(Signature & Title)

(SEAL)

_____
Address

_____

_____
Witness as to Principal

_____
Address

_____

SURETY:

_____

_____
Surety (Company)

_____
(Surety) Secretary

By:_____
Attorney–in–Fact

(SEAL)

_____
Witness as to Surety

_____
Address

_____

Notes:

1. Date of Bond must not be prior to date of Contract. If Contractor is a Partnership, all partners should execute bond.

2. Bond must be countersigned by a South Carolina resident agent.

3. Surety companies executing bonds must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.

DOCUMENT 00 61 13.16

PAYMENT BOND FORM

KNOW ALL MEN BY THESE PRESENTS,

hereinafter called "Principal" and _____,
(Name & Address of Surety)

_____ of _____

State of _____, hereinafter called the "Surety" are held and

firmly bound unto **Kiawah River Plantation Holdings, LP and Ocean Boulevard Properties a South Carolina Limited Partnership**, hereinafter called the "Owner" in

the penal sum of:

_____
(Contract Sum)

lawful money of the United States of America, to be paid to OWNER, for the payment whereof well and truly to be made we do bind ourselves, our respective executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the above bounden Principal has entered into a certain contract with the Owner dated the _____day of _____, 20__ for the construction of:

Kiawah River Planation Wastewater Treatment Plant (WWTP) on Johns Island, SC

Which said contract is incorporated hereby by reference and made a part hereof, and is hereinafter referred to as the Construction Contract.

NOW THEREFORE, THE CONDITION OF THIS OBLIGATION is such, if the Principal shall promptly make payment to all claimants as hereinafter defined, for all labor and materials supplied in the prosecution of the work provided for in said Construction Contract, then this obligation shall be void; otherwise it shall remain in full force and effect, subject, however, to the following conditions:

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

2. With respect to the Owner, this obligation shall be null and void if the Contractor:

   2.1 Promptly makes payment, directly or indirectly, for all sums due Claimants; and

2.2 Defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity whose claim, demand, lien, or suit is for payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, provided the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety, and provided there is no Owner Default.

3. With respect to Claimants, this obligation shall be null and void if the Contractor promptly makes payment, directly or indirectly, for all sums due.

4. The Surety shall have no obligation to Claimants under this Bond until:

4.1 Claimants who are employed by or have a direct contract with the Contractor have given notice to the Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to the Owner, stating a claim is being made under this Bond and, with substantial accuracy, the amount of claim.

4.2 Claimants who do not have a direct contract with the Contractor:

4.2.1 Have furnished written notice to the Contractor and sent a copy, or notice thereof, to the Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials were furnished or supplied or for whom the labor was performed; and

4.2.2 Have either received a rejection in whole or in part from the Contractor, or not received within 30 days of furnishing the above notice, any communication from the Contractor by which the Contractor has indicated the claim will be paid directly or indirectly; and

4.2.3 Not having been paid within 30 days, have sent a written notice to the Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to the Owner, stating a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to the Contractor.

5. Compliance shall be considered sufficient if a notice required by paragraph 4 is given by the Owner to the Contractor or to the Surety.

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

6.1 Send an answer to the Claimant, with a copy to the Owner, within 45 days after receipt of the claim stating the amounts undisputed and basis for challenging any amounts disputed.

6.2 Pay or arrange for payment of any undisputed amounts.

7. The Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by the Surety.

8. Amounts owed by the Owner to the Contractor under the Construction Contract shall be used for the performance of the Construction Contract and to satisfy claims, if any, under any Construction Performance Bond. By the Contractor furnishing and the Owner accepting this Bond, they agree all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfy obligations of the Contractor and the Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

9. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor unrelated to the Construction Contract. The Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

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

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

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

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

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

15. DEFINITIONS:

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

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

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

IN WITNESS WHEREOF, this instrument is executed in three counterparts, each one of which shall be deemed an original, on this the ____ day of _____.

CONTRACTOR AS PRINCIPAL:

_____
Principal

_____
(Principal) Secretary

By:_____
(Signature & Title)

(SEAL)

_____
Address

_____

_____
Witness as to Principal

_____
Address

_____

SURETY:

_____

_____
Surety (Company)

_____
(Surety) Secretary

By:_____
Attorney–in–Fact

(SEAL)

_____
Witness as to Surety

_____
Address

_____

Notes:

1. Date of Bond must not be prior to date of Contract. If Contractor is a Partnership, all partners should execute bond.

2. Bond must be countersigned by a South Carolina resident agent.

3. Surety companies executing bonds must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by

ACEC
American Council of Engineering Companies

The Associated General Contractors of America — Skill Responsibility Integrity

ASCE American Society of Civil Engineers

National Society of Professional Engineers
Professional Engineers in Private Practice

AMERICAN COUNCIL OF ENGINEERING COMPANIES

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Endorsed by

CONSTRUCTION SPECIFICATIONS INSTITUTE

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

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.

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

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

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

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

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

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

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

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

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

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

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

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

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

30. *PCBs*—Polychlorinated biphenyls.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

51. *Work Change Directive*—A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an

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

1.02 *Terminology*

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

B. *Intent of Certain Terms or Adjectives:*

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

C. *Day:*

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

D. *Defective:*

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

a. does not conform to the Contract Documents; or

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

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

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

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

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

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

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

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

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

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

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

2.02 *Copies of Documents*

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

2.03 *Commencement of Contract Times; Notice to Proceed*

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

2.04 *Starting the Work*

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

2.05 *Before Starting Construction*

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

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

2. a preliminary Schedule of Submittals; and

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

2.06 *Preconstruction Conference; Designation of Authorized Representatives*

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

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

2.07 *Initial Acceptance of Schedules*

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

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on

Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

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

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

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

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

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

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

3.02 *Reference Standards*

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

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

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

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

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

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

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

B. *Resolving Discrepancies:*

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

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

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

3.04 *Amending and Supplementing Contract Documents*

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

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

1. A Field Order;

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

3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier shall not:

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

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

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

3.06 *Electronic Data*

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

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

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

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

4.01 *Availability of Lands*

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

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

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

4.02 *Subsurface and Physical Conditions*

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

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

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

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

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

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

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

4.03 *Differing Subsurface or Physical Conditions*

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

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

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

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

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

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

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

C. *Possible Price and Times Adjustments:*

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

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

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

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

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

b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and

contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or

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

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

4.04 *Underground Facilities*

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

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

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

a. reviewing and checking all such information and data;

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

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

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

B. *Not Shown or Indicated:*

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

consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

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

4.05 *Reference Points*

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

4.06 *Hazardous Environmental Condition at Site*

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

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

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

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

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

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

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

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

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

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

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

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

ARTICLE 5 – BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

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

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

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

5.02 *Licensed Sureties and Insurers*

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

meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 *Certificates of Insurance*

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

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

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

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

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

5.04 *Contractor's Insurance*

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

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

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

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

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

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

b. by any other person for any other reason;

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

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

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

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

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

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

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

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

6. include completed operations coverage:

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

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

5.05 *Owner's Liability Insurance*

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

5.06 *Property Insurance*

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

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

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

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

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

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

6. include testing and startup; and

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

B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors,

members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.

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

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

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

5.07 *Waiver of Rights*

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

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

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

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

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

5.08 *Receipt and Application of Insurance Proceeds*

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

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

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

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

interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

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

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

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

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

6.02 *Labor; Working Hours*

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

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

6.03 *Services, Materials, and Equipment*

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

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

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

6.04 *Progress Schedule*

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

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

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

6.05 *Substitutes and "Or-Equals"*

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

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

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

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

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

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

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

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

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

2. *Substitute Items:*

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

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

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

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

1) shall certify that the proposed substitute item will:

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

b) be similar in substance to that specified, and

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

2) will state:

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

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

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

3) will identify:

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

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

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

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

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

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

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

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

6.06 *Concerning Subcontractors, Suppliers, and Others*

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

required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.

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

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

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

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

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

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

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

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as a loss payee on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner,

Contractor, Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

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

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

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

6.08 *Permits*

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

6.09 *Laws and Regulations*

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

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

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

6.10 *Taxes*

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

6.11 *Use of Site and Other Areas*

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

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

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

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought

by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

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

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

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

6.12 *Record Documents*

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

6.13 *Safety and Protection*

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

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

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

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

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and

shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

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

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

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

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

6.14 *Safety Representative*

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

6.15 *Hazard Communication Programs*

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

6.16 *Emergencies*

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

required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

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

1. *Shop Drawings:*

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

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

2. *Samples:*

a. Submit number of Samples specified in the Specifications.

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

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

C. *Submittal Procedures:*

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

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

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

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

d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

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

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

D. *Engineer's Review:*

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

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

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

E. *Resubmittal Procedures:*

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

6.18 *Continuing the Work*

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

6.19 *Contractor's General Warranty and Guarantee*

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

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

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

2. normal wear and tear under normal usage.

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

1. observations by Engineer;

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

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

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

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

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

7. any correction of defective Work by Owner.

6.20 *Indemnification*

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

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

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

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

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

6.21 *Delegation of Professional Design Services*

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

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

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

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

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

ARTICLE 7 – OTHER WORK AT THE SITE

7.01 *Related Work at Site*

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

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

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

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

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

7.02 *Coordination*

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

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

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

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

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

7.03 *Legal Relationships*

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

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

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

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

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

8.02 *Replacement of Engineer*

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

8.03 *Furnish Data*

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

8.04 *Pay When Due*

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

8.05 *Lands and Easements; Reports and Tests*

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

8.06 *Insurance*

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

8.07 *Change Orders*

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

8.08 *Inspections, Tests, and Approvals*

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

8.09 *Limitations on Owner's Responsibilities*

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

8.10 *Undisclosed Hazardous Environmental Condition*

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

8.11 *Evidence of Financial Arrangements*

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

8.12 *Compliance with Safety Program*

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

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

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

9.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or

continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

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

9.04 *Authorized Variations in Work*

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

9.05 *Rejecting Defective Work*

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

9.06 *Shop Drawings, Change Orders and Payments*

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

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

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

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

9.07 *Determinations for Unit Price Work*

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

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

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

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

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

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

9.09 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise

or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

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

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

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

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

9.10 *Compliance with Safety Program*

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

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

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

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

10.02 *Unauthorized Changes in the Work*

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

10.03 *Execution of Change Orders*

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

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

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

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

10.04 *Notification to Surety*

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

10.05 *Claims*

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

B. *Notice:* Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data

shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).

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

1. deny the Claim in whole or in part;

2. approve the Claim; or

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

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

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

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

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

11.01 *Cost of the Work*

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

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

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

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

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

5. Supplemental costs including the following:

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

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

    c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of

said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

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

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

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

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

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

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

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

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

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

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

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not

limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

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

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

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

11.02 *Allowances*

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

B. *Cash Allowances:*

1. Contractor agrees that:

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

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

C. *Contingency Allowance:*

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

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

11.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to

the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

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

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

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

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

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

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

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

12.01 *Change of Contract Price*

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

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

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

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

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

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

1. a mutually acceptable fixed fee; or

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

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

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

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

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

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

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

12.02 *Change of Contract Times*

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

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

12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or

neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.

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

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

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

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

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

13.01 *Notice of Defects*

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

13.02 *Access to Work*

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

13.03 *Tests and Inspections*

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

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

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

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

3. as otherwise specifically provided in the Contract Documents.

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

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

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

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

13.04 *Uncovering Work*

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

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

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

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

13.05 *Owner May Stop the Work*

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

13.06 *Correction or Removal of Defective Work*

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

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

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

1. repair such defective land or areas; or

2. correct such defective Work; or

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

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

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

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

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

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

13.08 *Acceptance of Defective Work*

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

13.09 *Owner May Correct Defective Work*

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

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

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

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

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

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

14.02 *Progress Payments*

A. *Applications for Payments:*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an

Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

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

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

B. *Review of Applications:*

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

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

   a. the Work has progressed to the point indicated;

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

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

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

   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or

involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or

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

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

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

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

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

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

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

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

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

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

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

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

C. *Payment Becomes Due:*

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

D. *Reduction in Payment:*

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

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

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

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

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

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remedies the reasons for such action.

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

14.03 *Contractor's Warranty of Title*

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

14.04 *Substantial Completion*

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

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

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before

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

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

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

14.05 *Partial Utilization*

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

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

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

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

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

14.06 *Final Inspection*

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

14.07 *Final Payment*

A. *Application for Payment:*

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

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

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

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

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

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

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

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

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying

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

C. *Payment Becomes Due:*

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

14.08 *Final Completion Delayed*

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

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

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

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

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

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

15.02 *Owner May Terminate for Cause*

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

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

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

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

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

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

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

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

3. complete the Work as Owner may deem expedient.

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

so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

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

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

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

15.03 *Owner May Terminate For Convenience*

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

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

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

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

4. reasonable expenses directly attributable to termination.

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

15.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days

to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

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

ARTICLE 16 – DISPUTE RESOLUTION

16.01 *Methods and Procedures*

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

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

C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

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

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

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

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

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

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

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

17.02 *Computation of Times*

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

17.03 *Cumulative Remedies*

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

17.04 *Survival of Obligations*

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

17.05 *Controlling Law*

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

17.06 *Headings*

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

DOCUMENT 00 73 00

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, Section 00 72 43, (EJCDC C–700, 2007 Edition) and other provisions of the Contract Documents as indicated below. All provisions that are not so amended or supplemented remain in full force and effect.

SC–1 The terms used in these Supplementary Conditions which are defined in the Standard General Conditions of the Construction Contract, Section 00 72 43, (EJCDC C–700, 2007 Edition) have the meanings assigned to them in the General Conditions.

SC–2.05.A.4 Add the following new paragraph to the General Conditions after paragraph 2.05.A.3:

4. "A schedule of anticipated shipping dates for materials and equipment. It is intended that equipment and materials be so scheduled as to arrive at the job site just prior to time for installation to prevent excessive materials on hand for inventory and necessity for extensive storage facilities at the job site."

SC–5.04.B.7 Add the following new paragraph to the General Conditions after paragraph 5.04.B.6:

7. Bonding surety shall be located in the state in which the work is being performed.

The Contractor shall not commence work under this contract until it has obtained all the insurance required under this paragraph and such insurance has been accepted by the Owner, nor shall the Contractor allow any Subcontractor to commence work on its subcontract until the insurance required of the Subcontractor has been so obtained and accepted.

a. Compensation and Employer's Liability Insurance: The Contractor shall take out and maintain during the life of the contract, the statutory Worker's Compensation and Employer's Liability Insurance for all of its employees to be engaged in work on the project. When applicable, the Contractor shall require the Subcontractor to provide similar Worker's Compensation and Employer's Liability Insurance for all the Subcontractor's employees that are engaged in work on the project.

b. Bodily Injury Liability and Property Damage Liability Insurance: The Contractor shall take out and maintain during the life of the contract, Bodily Injury Liability and Property Damage Liability Insurance. The policy shall protect Contractor and any Subcontractor performing work covered by the contract from claims for damages or personal injury, including accidental death, as well as from claims for property damage, which may arise from

operations under the contract, whether such operations be by Contractor, Subcontractor, or by anyone directly or indirectly employed by either of them. The amount of such insurance should be not less than:

(1) Bodily Injury Liability Insurance, in an amount not less than $1,000,000.00 for injuries, including wrongful death to any one person and subject to the same limit for each person in an amount not less than $2,000,000.00 on account of one accident. Contractual liability should be endorsed on the policy.

(2) Property Damage Insurance in an amount not less than $1,000,000.00 for damages on account of any one accident, and in an amount not less than $2,000,000.00 for damages on account of all accidents.

c. Builder's Risk Insurance (Fire and Extended Coverage): The Contractor shall have adequate fire and standard extended coverage, with a company or companies acceptable to the Owner, in force on the project.

The provisions with respect to Builder's Risk Insurance shall, in no way, relieve the Contractor of its obligation of completing the work covered by the Contract.

d. Proof of Carriage of Insurance: The Contractor shall furnish the Owner with certificates showing the type, amount, class of operations, effective dates, and date of expiration of policies. Such certificates shall contain substantially the following statement: "The insurance covered by this certification shall not be canceled or materially altered, except after a 10 day written notice has been received by the Owner."

SC–6.02.B Add the following:

The Contractor shall provide in writing any requests to work on weekends. Requests shall be submitted to the Owner and Engineer for consideration a minimum of 48-hours prior to the requested weekend.

SC–6.08 Add the following:

The Contractor shall not proceed until all encroachment permits, curb cut permits, highway crossing permits, and railroad crossing permits have been secured. Contact Owner or Owner's Representative to ascertain status of permits.

SC–6.09.D Add a new paragraph after paragraph 6.09.C of the General Conditions that reads as follows:

"D. The Contractor shall comply with the Department of Labor Safety and Health Regulations for Construction promulgated under the Occupational

Safety and Health Act of 1970 as amended through January 1, 2004 (PL 91–596) and under Section 107 of the Contract Work and Safety Standards Act (PL 91–54). The regulations are administered by the Department of Labor and the Contractor shall allow access to the project to personnel from that Department.

The Bidder's attention is directed to the fact that all applicable State laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout, and they will be deemed to be included in the contract the same as though herein written in full.

The Contractor shall keep fully informed of all laws, ordinances and regulations of Federal, State, City and County, in any manner affecting those engaged or employed in the work, or the materials used in the work, or in any way affecting the conduct of the work, and of all orders and decrees of bodies or tribunals having any jurisdiction or authority over same. Contractor shall at all times, observe and comply with all such existing and future laws, ordinances, and regulations."

SC–6.12.B Add a new paragraph after paragraph 6.12.A of the General Conditions that reads as follows:

"B. Record Data Drawings:

1. The Contractor shall keep accurate, legible records of the elevations, locations, types, and sizes of sanitary sewage lines, service laterals, manholes, cleanouts, water lines, fittings, valves, hydrants, drainage pipes, drainage structures, and other related work performed under this project. Where proposed and existing utilities cross, the Contractor shall measure and record the horizontal location and vertical separation between each crossing. Separation shall be measured between exteriors of pipes. On a set of project prints provided by the Owner, the Contractor shall prepare a set of "record" drawings from the data stated above. The horizontal locations of all portions of items installed on this project shall be accurately tied down to the State Plane Coordinate System. Invert and frame elevations of all manholes, storm sewers and structures, sanitary sewers and lift stations shall be clearly indicated. These "record" drawings shall be kept clean and dry and maintained in a current state with the progress of the work. If at any time, a copy of this plan or portion of it is requested by the Owner, such copy shall be made available within 24 hours after the request is made.

2. Before final acceptance of the completed installation and before final payment by the Owner, the Contractor shall deliver to the Engineer a completed set of "record" drawings accurately depicting the data described above.

SC–6.13.A.3 Add the following:

"Safely guard the Owner's property from damages, injury, or loss in connection with this contract. Contractor shall at all times guard and protect its own work and all materials of every description both before and after being used in the work.

Contractor shall provide any enclosing or special protection from weather deemed necessary by Engineer without additional cost to the Owner. Partial payments under the contract will not relieve the Contractor from responsibility for protection of material, work, and property."

SC–9.02.C Add a new paragraph after paragraph 9.02.B of the General Conditions that reads as follows:

"C. If, at any time before the commencement or during the progress of the work, tools, plant or equipment appear to the Engineer to be insufficient, inefficient, or inappropriate to secure the quality of the work required or the proper rate of progress, the Engineer may order the Contractor to increase their efficiency, to improve their character, to augment their number, or to substitute new tools, plant or equipment as the case may be, and the Contractor must conform to such order; but a failure of the Engineer to demand such increase or efficiency, number, or improvements, shall not relieve the Contractor's obligation to secure the quality of work and the rate of progress necessary to complete the work within the time required by this contract to the satisfaction of the Owner."

SC–9.05 Add the following sentences at the end of paragraph 9.05 of the General Conditions:

"Owner and Engineer have the right to reject defective materials. Defective materials shall not be used in the work."

SC–13.03.A Add the following sentences to paragraph 13.03.A of the General Conditions:

"The Contractor will be required to maintain all work in a condition acceptable to the Engineer for a 30 day operating period after the same has been completed as a whole, and the Engineer has notified the Contractor in writing that the work has been finished. The Contractor shall give the Project Engineer or Project Representative a minimum of 48-hours of notice for all required observations and tests, unless stated otherwise in the Specifications or Drawings."

END OF SUPPLEMENTARY CONDITIONS

DOCUMENT 00 80 00

SPECIAL CONDITIONS

SC–1 DESCRIPTION OF THE WORK: The work consists of construction of new Wastewater Treatment Facility and incidental construction in accordance with the Drawings and Specifications.

SC–2 COMMENCEMENT AND COMPLETION OF WORK: Refer to Section 00 72 00 Standard General Conditions for timeline of commencement of work.

If the Contractor fails to prosecute the work with such diligence as will insure the completion of each portion of the work within the contractually agreed upon schedule, plus any extensions made in accordance with Article 12 of the General Conditions; and, if the Owner does not exercise reservations as set forth in Article 13 of the General Conditions, the Contractor shall continue the work in which event liquidated damages for the delay will be impossible to determine. In lieu thereof, liquidated damages shall be paid for each day of delay of the work until the work is completed.

SC–3 DRAWINGS: The work shall conform to the drawings, all of which form a part of, and are included in, these specifications and are available in the office of Thomas & Hutton Engineering Co., 682 Johnnie Dodds Boulevard, Suite 100, Mt. Pleasant, South Carolina, 29464.

SC–4 LAYOUT OF WORK: Control lines and master benchmarks will be furnished by the Owner. The Contractor will lay out work and will be responsible for all measurements in connection therewith.

SC–5 OBSERVATIONS AND TESTS: Before acceptance of the whole or any part of the work, it shall be subjected to observation and tests to determine it is in accordance with the Drawings and Specifications. The Contractor will be required to maintain all work in a first class condition for a 30 day operating period after the same has been completed as a whole and the Engineer has notified the Contractor in writing that the work has been finished. The Owner shall pay for all testing and shall engage a mutually acceptable laboratory or qualified individual to conduct the tests in accordance with these specifications. No portion of the work will be accepted until tests prove it has been satisfactorily completed.

SC–6 BONDS: The Performance Bonds in the amount of 100% of the contract amount and Payment Bonds in the amount of 100% of the contract amounts shall be furnished in accordance with Article 5 of the General Conditions.

SC–7 CONTRACTOR'S AND SUBCONTRACTOR'S INSURANCE: The Contractor shall not commence work under this contract until obtaining all the insurance required under this paragraph and such insurance has been accepted by the Owner, nor shall the Contractor allow any Subcontractor to commence work on a subcontract until the insurance required of the Subcontractor has been so obtained and accepted.

a. Compensation and Employer's Liability Insurance: As stated in Section 00 73 00 Supplementary Conditions.

b. Bodily Injury Liability and Property Damage Liability Insurance: As stated in Section 00 73 00 Supplementary Conditions.

c. Builder's Risk Insurance (Fire and Extended Coverage): As stated in Section 00 73 00 Supplementary Conditions.

d. Proof of Carriage of Insurance: As stated in Section 00 73 00 Supplementary Conditions.

SC–8 HOLD HARMLESS CLAUSE: The Contractor agrees to hold harmless, indemnify, and defend the Owner and its agents, architects, engineers, and employees from and against any and all claims, losses, damages, demands, causes of action, and any and all related costs and expenses, of every kind and character, growing out of, incidental to, or resulting directly or indirectly from the Contractor's performance of the work described herein, whether such loss, damage, injury, or liability is contributed to by the negligence of the Owner, its agents, architects, engineers, or employees, except the Contractor shall have no liability for damages or the costs incidental thereto caused by the sole negligence of the Owner, its agents, architects, engineers, or employees. The Contractor will require any and all subcontractors to conform with the provisions of this clause prior to commencing any work and agrees to ensure this clause is in conformity with the insurance provisions of the contract.

SC–9 CONTRACTOR'S STATUS: It is agreed the Contractor shall occupy the status of an Independent Contractor and the Contractor's employees are not employees of the Owner.

SC–10 CONTRACTOR'S AFFIDAVIT: Upon completion of the work and prior to final payment and settlement of all sums due hereunder, Contractor will furnish to Owner a Contractor's Affidavit in the usual form submitted by Contractor under the laws of the State of South Carolina, to the effect all bills for labor, materials, and services in connection with said contract have been paid in full, acknowledging receipt of the contract price, and averring there are no outstanding claims under said contract which could become a lien on the real estate arising out of said contract.

SC–11 RESIDENT PROJECT ENGINEER: The Owner reserves the right to furnish a Resident Project Engineer as deemed necessary to insure the Project quality control and conformance to Plans and Specifications, who will act as the Owner's Representative on the Project and will have the authority of the Engineer as set forth in the Contract Documents.

SC–12 BARRICADES, DANGER AND WARNING SIGNS: The Contractor shall install and maintain barricades, suitable and sufficient lights, danger signals, signs, and other traffic control devices and shall take all necessary precautions for the protection of the work and safety of the public. Lanes closed to traffic shall be protected by effective barricades, lighted during hours of darkness. Suitable warning signs shall be provided to control, direct traffic, and warn pedestrians. Upon completion all barricades, signs and the like shall be removed.

SC–13 TOOLS, PLANT AND EQUIPMENT: If at any time before the commencement or during the progress of the work, tools, plant or equipment appear to the Engineer to be insufficient, inefficient, or inappropriate to secure the quality of the work required or the proper rate of progress, the Engineer may order the Contractor to increase their efficiency, to improve their character, to augment their number, or to substitute new tools, plant, or equipment, as the case may be, and the Contractor must conform to such order; but a failure of the Engineer to demand such increase of efficiency, number, or improvement shall not relieve the Contractor of its obligation to secure the quality of work and the rate of progress necessary

to complete the work within the time required by the contract to the satisfaction of the Owner.

SC–14 ACCIDENTS: The Contractor shall provide, at the site, such equipment and medical facilities as are necessary to supply first–aid service to anyone who may be injured in connection with the work. The Contractor must report in writing to the Engineer all accidents whatsoever arising out of, or in connection with, the performance of the work, whether on or adjacent to the site, which causes death, personal injury, or property damages, giving full details and statement of witnesses. In addition, if death or serious injuries or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Contractor and any subcontractor on account of any accident, the Contractor shall promptly report the facts to the Engineer, giving full details in writing of the claim. The Contractor shall advise its superintendent and foreman, who are on the site of the work, the name of the hospital and phone number and the name and phone number of the doctor to use in case of an accident.

SC–15 SANITARY PROVISIONS: The Contractor shall provide temporary sanitary facilities for the use of the workmen during the progress of the work. The sanitary facilities shall conform to the requirements of the County health Engineer. All facilities shall be removed at the completion of the contract.

SC–16 MODIFICATION OF QUANTITIES: The itemized quantities shall be considered by the Contractor as the quantities required to complete the work for the purpose of bidding. Should actual quantities required in the construction of the work be greater or less than the quantities shown on the items, an amount equal to the difference in quantities at the unit prices for the item will be added to or deducted from the contract price.

When itemized quantities are not given in the Proposal, the work shown on the plans or specified shall be considered by the Contractor to be included in the contract for the lump sum prices bid.

SC–17 RESPONSIBILITY REGARDING EXISTING UTILITIES AND STRUCTURES: The existence and location of underground utilities will be investigated and verified in the field by the Contractor before starting work. The Contractor shall call for underground utility locations. Underground utilities location service can be contacted at 1–888–721–7877 (SC) or 811. The location of all known interferences based on the best information available has been shown on the drawings, but this information may not be complete. Excavation in the vicinity of existing structures and utilities shall be carefully done by hand. The Contractor shall be held responsible for any damage to and for maintenance and protection of existing utilities and structures. The Contractor is responsible for coordinating with the utility companies any relocation, adjustment, or replacement of utility facilities.

SC–18 INTERRUPTION OF UTILITY SERVICE: The Contractor's operations shall be conducted to interfere as little as possible with utility services. Any proposed interruption by the Contractor must be accepted in advance by the Engineer.

SC–19 OMISSION: The drawings and specifications shall both be considered as a part of the contract. Any work and material shown in the one and omitted in the other, or described in the one and not shown in the other, or which may fairly be implied by both or either, shall be furnished and performed as though shown in both, in order to give a complete and first class job.

SC–20 MEASUREMENT AND PAYMENT: Measurement and payment shall be made for the units and at the lump sum contract prices shown on the Bid Schedule. Direct payment shall only be made for those items or work specifically listed in the proposal and the cost of any other work must be included in the contract price for the applicable items to which it relates.

SC–21 "OR EQUIVALENT," CLAUSE: Although the plans and specifications make reference to particular manufacturers and model numbers for various products, such reference is made only to establish function and quality of such products. If it is desired to use materials or equipment of trade names or of manufacturer's names that are different from those mentioned in the contract documents, information pertaining to such items must reach the hands of the Engineer at least 10 days prior to the date set for the opening of bids. The burden of proving equality of a proposed substitute to an item designated by trade name or by manufacturer's name in the contract document rests on the party submitting the request for acceptance. The written application for review of a proposed substitute must be accompanied by technical data that the party requesting review desires to submit in support of its application. The Engineer will give consideration to reports from reputable independent testing laboratories, verified experience records showing the reputation of the proposed product with previous users or any other written information that is reasonable in the circumstances. The application to the Engineer for review of a proposed substitute must be accompanied by a schedule setting forth in what respects the material or equipment submitted for consideration differs from the materials or equipment designated in the contract documents. The degree of proof required for acceptance of a proposed substitute as equivalent to a named product is the amount of proof necessary to convince the Engineer beyond all doubt. To be acceptable, a proposed substitute must, in addition, meet or exceed all express requirements of the contract documents.

If submittal is accepted by the Engineer, an addendum will be issued to all prospective bidders at least five days prior to the date set for the opening of bids.

The Engineer shall be the final judge on questions of similarity and equality.

SC–22 SAFETY AND HEALTH REGULATIONS: The Contractor shall comply with the Department of Labor Safety and Health Regulations for Construction promulgated under the Occupational Safety and Health Act of 1970 as amended through January 1, 2004 (PL 91–596) and under Section 107 of the Contract Work and Safety Standards Act (PL 91–54). The regulations are administered by the Department of Labor and the Contractor shall allow access to the project to personnel from that Department.

SC–23 RECORD DATA AND DRAWINGS: The Contractor shall keep accurate, legible records of the locations, types, and sizes of sanitary lines, service laterals, manholes, cleanouts, water lines, fittings, valves, hydrants, drainage pipes, drainage structures, and other related work performed under this project. Where proposed and existing utilities cross, the Contractor shall measure and record the horizontal location and vertical separation between each crossing. Separation shall be measured between exteriors of pipes. On a set of project prints provided by the Owner, the Contractor shall prepare a set of "record" drawings from the data stated above. The horizontal locations of all portions of items installed on this project shall be accurately tied down to features that are physical and visible, such as property corner markers and/or permanent type structures. Invert elevations of all manholes, storm sewers and structures, sanitary sewers and lift stations shall be clearly indicated. These "record" drawings shall be kept clean and dry and maintained in a current state with the progress of the work. If at any time, a copy of this plan or portion of it is requested by the Owner, such copy shall be made available within 24 hours after the request is made.

Before final acceptance of the completed installation and final payment by the Owner, the Contractor shall deliver to the Engineer, four sets of "Record" Drawings accurately depicting the horizontal and vertical as–built data described in the above paragraph. "Record" drawings for the items installed on this project shall be certified by a licensed surveyor, other than Thomas & Hutton, registered in South Carolina. The size of the drawings shall be 24" x 36". The "Record" drawings shall have a coordinate system based on the South Carolina State Plane Coordinate System, East Zone, North American Datum of 1983 (NAD83). Elevations shall be based on the North American Vertical Datum of 1988 (NAVD 88). All measurements and coordinates shown shall use the U.S. Survey flood definition. Coordinates shall be shown on all drainage structures, sanitary sewer manholes, storm manholes/boxes, valve boxes/vaults, valve manholes, valves, fire hydrants, fittings, and all other related work performed under this contract. Vertical data including but not limited to, structure and manhole frame and inverts, pipe inverts, lift station frame, inverts, control levels, bottom, site grading, and as–built grading shall be shown. In addition to the "Record" drawings, Contractor shall deliver to Engineer electronic AutoCAD (v. 14 or later) files of all the data described above on a CD–ROM.

SC–24 PROPERTY CORNERS: The Contractor shall be responsible for restoring any property corners or monuments disturbed during construction. They shall be restored by a professional surveyor registered in the State of South Carolina.

SC–25 VIDEO: A video showing existing site conditions shall be made by the Contractor prior to start of construction. Contractor shall provide Owner and Engineer a copy of the video. Contractor is encouraged to record any existing damaged facilities that could be questioned later by property owners. A written or recorded narrative shall be provided with the video. Engineer shall be notified 72 hours in advance making the video. Contractor is responsible for all costs associated with video and shall be considered a subsidiary part of the contract.

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PART 10 – SUBMITTALS DURING CONSTRUCTION

SECTION 01 00 01

GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 DEFINITIONS

A. Not Used

1.02 DESIGN REQUIREMENTS

A. Provide systems, equipment, and components, including supports and anchorages for the design criteria stated on the Drawings, in accordance with the provisions of the 2006 International Building Code (IBC) or the latest applicable Building Code and the South Carolina Amendments.

B. These requirements take precedence over other requirements provided elsewhere, subject to Engineer approval.

1.03 ENVIRONMENTAL REQUIREMENTS FOR PAINTING, COATINGS, AND MATERIAL SELECTIONS

A. Throughout the individual Specification sections, the materials of construction and paint and coating systems to be used for some items are dependent upon the specific environment types to which the items will be exposed, as defined below.

B. Environment Types:

1. Interior Dry: Location inside building or structure where floor is not subject to liquid spills or wash down, nor where wall or roof slab is common to a water–holding or earth–retaining structure.

2. Interior Wet: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab are common to a water–holding or earth retaining structure.

3. Submerged: Location at or below top of wall of open water–holding structure, such as a basin or channel; or wall, ceiling, or floor surface inside a covered water–holding structure, such as a submersible pump station, scum pit, or manhole; or exterior below grade wall or roof surface of water–holding structure, open or covered.

4. Corrosive: Containment area or area exposed to delivery, storage, transfer, and use of chemicals.

5. Exterior: Location not protected from the weather by a building or other enclosed structure.

C. The individual Specifications define the materials of construction required for the various environment types, unless the material for the item is specifically called

out otherwise on the Drawings or Details.

PART 2 – SUMMARY OF WORK

2.01 SPECIFICATIONS AND DRAWINGS

A. The Specifications and Drawings included in these Contract Documents establish the performance, quality requirements, location, and general arrangement of materials and equipment, and establish the minimum standards for quality of workmanship and appearance. There has been no attempt to separate the Specification sections into groups for work of contractors or various trades. Should there be questions concerning the applicability or interpretation of a particular Specification section or part of a Specification section or Drawing, the questions should be directed to the Owner or Engineer prior to the submittal of a proposal for the Work under this Contract.

2.02 INCLUSIONS

A. Any part of the Work that is necessary or required to make each installation satisfactorily and legally operable, even though it is not specifically included in the Specifications or on the Drawings, shall be performed as incidental work as if described in the Specifications and shown on the Drawings. The expense of such incidental work shall be included in the lump sum bid.

B. The Contractor shall furnish all shop drawings, work drawings, labor, materials, equipment, tools, services and incidentals necessary to complete all work required by these Specifications and shown on the Contact Drawings.

C. The Contractor shall perform the work complete, in place ready for continuous service and shall include any repairs, replacements, or restoration required as a result of damages caused prior by acceptance by Owner.

D. The Contractor shall furnish and install all materials, equipment and labor which is reasonably and properly inferable and necessary for the proper completion of the work, whether specifically indicated in the Contract Documents or not.

E. Coordinate, cooperate and work with MBR manufacturer to provide complete and fully operational system.

F. Ovivo has been chosen to provide Flat Plate MBR membranes and related equipment for this project. Contractor shall engage Ovivo to provide the materials, labor, engineering, and related for a complete and functioning system. The Ovivo contact for this project is Damone Supica, who can be reached at 865-429-2002 or 865-466-0088 or by email at Damone.Supica@ovivowater.com. Contact Ovivo for their scope of supply and scope of work.

2.03 OWNER OCCUPANCY

A. The Owner intends to occupy and keep operational facilities in the project area during the life of construction.

B. Cooperate with Owner to minimize conflict with existing operations and to facilitate Owner's operations.

C. Cooperate and coordinate with Owner to provide uninterrupted security and operation.

D. Contractor shall maintain uninterrupted access to compound during life of project.

E. Any impacts to traffic or operations shall be approved by the Owner at least ten business days prior to impact.

2.04 CONSTRUCTION AREAS

A. The Contractor shall limit his use of the construction areas for work and for storage, to allow for:

1. Work by Contractors.

2. Owner's Use.

3. Security.

B. Coordinate use of work site under direction of Engineer and Owner's Representative.

C. Assume full responsibility for the protection and safekeeping of products under this Contract, stored on the site.

D. Move any stored products under the Contractor's control, which interfere with operations of the Owner, or separate contractor.

E. Obtain and pay for the use of additional storage of work areas needed for Contractor operations.

2.05 PROJECT DESCRIPTION

A. A brief description of the Work is stated in these Documents. To determine the full scope of the project or any particular part of the Project, refer to the Specifications and Drawings.

B. The following additional information, though not all–inclusive, is given to assist contractors in their evaluation of the Work required to meet the Project objectives.

C. The New Wastewater Treatment Plant project consists of the following components (this is not an all-inclusive scope of work):

1. Headwork's facility, including mechanical screening and odor control associated.

2. Anoxic/Pre-aeration and membrane thickening basins including submersible mixer(s), diffused aeration system, blowers, and recycle pumps/wet well.
3. Membrane Bioreactor (MBR) basins and covered equipment area.
4. A two-story Building to provide the following:
   a. Blowers, pumps and other equipment.
   b. Storage and feed for sodium hydro chlorite, caustic soda, etc.
   c. Control Room, associated casework & equipment
   d. Electrical/MCC Room, associated equipment
   e. Mechanical Room, associated equipment
   f. Store Room
   g. Bath room and shower.
5. Monorail beam and hoist system for MBR filters.
6. Odor control units and associated for the plant and headworks.
7. Screenings dumpsters and slab for screenings and grit.
8. MBR filter wash pad on grade.
9. Screening structure.
10. Plant drain pump station.
11. Associated process and non–process yard and plant piping.
12. Associated site pavement, grading and related.
13. One diesel engine generator with fuel tank, mechanical and electrical accessories and access walkway.
14. Associated instrumentation and control equipment.
15. Associated communications system including Programmable Logic Controller (PLC), Input/output (I/O) modules and Scada.
16. Associated electrical equipment and work.
17. Associated grounding and lightning protection systems.
18. Site and facility lighting.
19. Land application system (LAS-piping, control valves, spray heads) with fencing.
20. Effluent pumping station.
21. Effluent holding pond with fencing.
22. Water supply line.
23. Centrifuge (dewatering) building and associated.
24. Chlorine contact basin.
25. Electrical, control, conduit, wiring, etc.
26. Plant fencing and landscape buffers/plants.
27. MBR membranes, equipment and related.
28. Piles and other structural supports.

2.06 WORK BY OTHERS

A. Construction activities (i.e. compacting, pile driving, etc.) generate vibrations. Therefore the Owner will have vibration monitoring performed. Contractor shall cooperate with the vibration monitoring company and provide at least a 15-working days' notice to Engineer before commencing pile driving operations.

PART 3 – SEQUENCE OF OPERATIONS

3.01 SCHEDULING

A. Plan the Work and carry it out with minimum interference to the operation of the Owner and other subcontractors. Prior to starting the Work, confer with the Owner to develop an approved work Schedule.

B. It may be necessary to do certain parts of the construction work outside normal working hours in order to avoid undesirable conditions as determined by the Engineer and Owner. The Contractor shall do this work at such times and at no additional cost to the Owner.

C. The Contractor shall provide a plan and sequence of construction to ensure minimum disruption to other subcontractors and the MBR System Supplier and the Owner, and shall accept the Owner's decisions for conflict resolution. The plan shall describe all operations with durations and sequence of operation. The plan shall indicate all temporary measures and connection to avoid interruptions. The plan shall be subject to the Owner's review and approval. The plan shall include shop drawing reviews, performance testing, start-up and related.

D. The Contractor shall be working onsite at the same time as the other subcontractors. All subcontractors shall coordinate their schedules with the Contractor and with each other and shall meet at a weekly construction coordination meeting for that purpose. More frequent coordination meetings may be required by the Contractor, Owner or Engineer if deemed necessary.

E. Overall Project Schedule:

1. General:

   a. Contractor shall submit with the bid proposal the name(s) of personnel who shall be responsible for the planning, scheduling, and updating of the Contractor's schedule. Contractor's personnel assigned to the planning and scheduling duties shall have substantive experience in the computer application of Critical Path Method (CPM) planning and scheduling.

   b. As a prerequisite to the approval of payment for work, Contractor shall be required to submit periodic updates to the Owner. The regularity of such updates shall be negotiated and agreed by the Contractor and Owner following contract award. Updates shall be at least monthly. All schedules submitted to the Owner shall be in a format acceptable to the Owner.

   c. Upon request by the Owner or Engineer, a current copy of the schedule shall be provided within 24 hours.

   d. Contractor shall be required to use the Precedence Diagram Method (PDM) of CPM planning and scheduling.

e. Contractor may employ a qualified Subcontractor or consultant to perform the planning; and scheduling duties. Assignment of a Subcontractor shall in no way alter or reduce the Contractor's obligations to perform the required planning and scheduling requirements.

f. It is the Contractor's sole responsibility to ensure that all of the Subcontractors and suppliers provide the required information, in sufficient detail, so that Contractor meets the requirements of the contract.

g. The Contractor shall maintain the Project Master Schedule. Contractor's schedules shall be incorporated in the development phase and at regular updates of the Project Master Schedule. Project float is for the use of the project and not for exclusive benefit of the Contractor. Float may be used to mitigate changes in the Work or other events which may delay performance or completion of the Project.

h. Work Restrictions: Show the effect of the following items, as applicable, on the schedule:
   1. Coordination with existing construction.
   2. Limitations of continued occupancies.
   3. Uninterruptible services.
   4. Partial occupancy before Substantial Completion.
   5. Use of premises restrictions.
   6. Environmental control.

i. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

   1. Submittals.
   2. Mockups.
   3. Fabrication.
   4. Sample testing.
   5. Deliveries.
   6. Installation.
   7. Tests and inspections.
   8. Building flush-out.
   9. Startup and placement into final use and operation.

j. Construction Areas: As applicable, identify each major area of construction for major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   1. Structural completion.
   2. Temporary enclose and space conditioning.
   3. Permanent space enclosure.
   4. Completion of mechanical installation.
   5. Completion of electrical installation.

6. Substantial Completion.

k. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Commencement of Work, Testing, Startup, Substantial Completion, Notice of Occupancy and Use, and Final Acceptance. As applicable, also include milestones for Partial Substantial Completion and Partial Notice of Occupancy and Use.

l. Recovery Schedule: When periodic update indicates the Work is fifteen or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

2. Submit detailed testing plant startup and performance monitoring schedule.

3. Progress Reports:
   a. Weekly progress coordination meetings shall be held at the jobsite and attended by the Contractor and Owner's Representative. The schedule shall be reviewed at each meeting. Immediately prior to the meeting, the Contractor shall obtain from the subcontractors the necessary information to update the Schedule to reflect progress to date. The updated Schedule shall be available at the meeting for review. At a minimum, the following items shall be reviewed at the meetings:
      1. Overall project schedule status.

      2. Activities started and completed during the previous week.

      3. The remaining duration required to complete each current activity.

      4. The remaining duration or schedule impacts for selected activities not yet started.

      5. The Change Orders and proposed sequencing changes to the network diagram.

3.02 PERMITTING

A. Contractor shall acquire all required permits associated with the work covered under this contract, and shall be responsible for all required application and permit fees. Contractor shall have the necessary local licenses including a county business license.

3.03 COORDINATION

A. Other Subcontractors, employed by the Owner directly, may be completing work

items on the property, independent of the scope of services for this contract. Contractor shall ensure coordination of his Subcontractor's with those employed by the Owner and the Owner.

B. If any difficulty or dispute should arise in the accomplishment of the above coordination or with concurrent activities on the property, the Owner shall be notified immediately.

C. All Subcontractors working for the Contractor on this site are subject to this requirement for cooperation, and all shall abide by the resolution agreed upon by the Contractor and Owner, without additional cost to the Owner.

3.04 EQUIPMENT AND SYSTEM TESTING

A. Specific performance testing of installed equipment and systems shall be conducted by the Contractor, Vendor, or Manufacturer's Representative in the presence of the Owner or Owner's Representative, as required in the Specifications and/or Drawings.

B. The Contractor shall furnish all labor, materials, tools, equipment, instruments, consumables, and services necessary to perform the functional and performance testing.

3.05 SEQUENCE OF CONSTRUCTION

A. Contractors shall first install tree protection and erosion protection, and have it inspected prior to commencing work.

B. The demolition and removal of portion of the existing plant shall occur after a permit to operate the new facility is received and the Owner issues a written notice.

PART 4 SITE CONDITIONS

4.01 SITE INVESTIGATION AND REPRESENTATION

A. The Contractor acknowledges satisfaction as to the nature and location of the Work, the general and local conditions, particularly those bearing upon availability of transportation, access to the site, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, or similar physical conditions at the Site, the conformation and conditions of the ground, the character of equipment and facilities needed prior to and during the execution of the Work, and all other matters which can in any way affect the Work or the cost thereof under this Contract.

B. The Contractor further acknowledges satisfaction as to character, quality, and quantity of surface and subsurface materials to be encountered from the contractor's inspection of the site and from reviewing any available records of exploratory work furnished by the Owner. Failure by the Contractor to become acquainted with the physical conditions of the site and all the available

information will not relieve the Contractor from responsibility for properly estimating the difficulty or cost of successfully performing the Work.

C. The Contractor warrants that, as a result of examination and investigation of all the aforesaid data, the Contractor can perform the Work in a good and workman–like manner and to the satisfaction of the Owner and Engineer. The Engineer assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this contract.

4.02 INFORMATION ON SITE CONDITIONS

A. General: Any information obtained by the Engineer regarding site conditions, subsurface information, groundwater elevations, existing construction of site facilities as applicable, and similar data will be available for inspection at the office of the Engineer upon request. Such information is offered as supplementary information only. The Engineer assumes no responsibility for the completeness or interpretation of such supplementary information.

4.03 SUBSURFACE INVESTIGATION

A. Subsurface investigations, including test borings, have been made to indicate subsurface materials at particular locations. Engineer assumes no responsibility whatsoever in respect to the sufficiency or accuracy of the interpretations made of subsurface conditions, and there is no warranty or guarantee, either expressed or implied, that the conditions indicated by such investigations are representative of those existing throughout such area, or any part thereof, or that unforeseen developments may not occur.

B. The Contractor may make arrangements with the Owner for permission to conduct, at the Contractor's own expense such additional subsurface investigation as may be necessary to verify existing conditions. Contractor shall share the results of those investigations with the Owner and Engineer.

4.04 DIFFERING SUBSURFACE CONDITIONS

A. In the event subsurface or latent physical conditions are found materially different from those indicated in these Documents, and differing materially from those ordinarily encountered and generally recognized as inherent in the character of work covered in these contract Documents, the Contractor shall promptly, and before such conditions are disturbed, notify the Owner and Engineer in writing of such changed conditions.

B. The Engineer will investigate such conditions promptly and following this investigation, the Contractor shall proceed with the Work, unless otherwise instructed. If the Engineer finds that such conditions do differ from those anticipated and subsequently, cause an increase or decrease in project cost, through materials, labor, schedule or other, then any adjustments in cost and time will be addressed as indicated in the General Conditions. The Engineer will make the final decision on all Change Orders to the contract regarding any adjustment in cost or time for completion.

4.05 UTILITIES

A. Contractor shall be responsible for identifying and locating any utilities before starting construction. Damage to any such utilities must be repaired by the Contractor at no additional cost to the Engineer or the Owner.

B. The following is a list of the major known utilities serving the Work area which should be notified if conflicts or emergencies arise during the progress of the Work:

Name of Utility

1. Electrical: SCE&G / BEC.
2. Phone: AT&T.
3. Water: St. Johns Water Company.
4. Gas: SCE&G.
5. Cable: Comcast, Knology (others possible).

4.06 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

A. Where the Contractor's operations could cause damage or inconvenience to telegraph, telephone, television, power, oil, gas, water, sewer, irrigation systems, or security systems, the operations shall be suspended until all arrangements necessary for the protection of these utilities and services have been made by the Contractor.

B. Notify all utility offices which are affected by the construction operation at least 72 hours in advance. Under no circumstances expose any utility without first obtaining permission from the appropriate agency or the Owner. Once permission has been granted, locate, expose, and provide temporary support for all existing underground utilities.

C. The Contractor shall be solely and directly responsible to the Owner and operators of such properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage which may result from the construction operations under this Contract.

D. Neither the Owner nor its Representative shall be responsible to the Contractor for damages as a result of the Contractor's failure to protect utilities encountered in the Work.

E. In the event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental breakage due to construction operations, Contractor shall promptly notify the Owner and the proper authorities. Contractor shall cooperate with said authorities and the Owner in restoration of service as promptly as possible and bear all costs of repair. In no case shall interruption of any water or utility service be allowed to exist outside working hours unless prior approval is granted by the owner of the utility and the Owner.

F. The Contractor shall replace, at the Contractor's own expense, all existing utilities or structures removed or damaged during construction, unless otherwise provided for in these Contract Documents or ordered by the Owner.

4.07 INTERFERING STRUCTURES

A. Take necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground.

4.08 FIELD RELOCATION

A. During the progress of construction, it is expected that relocations of the Work may be necessary. Such relocations shall be made only by direction of the Owner. If existing structures are encountered which prevent the construction, and which are not properly shown the Drawings, Contractor shall notify the Owner before continuing with the construction. Engineer shall be informed and, at the direction of the Owner, shall make any necessary field revisions to avoid conflict with the existing structures. If the Contractor shall fail to so notify the Owner when an existing structure is encountered, and proceeds with the construction despite this interference, the Contractor does so at his own risk.

PART 5 – SALVAGE OF MATERIALS

5.01 MATERIAL TO BE SALVAGED

A. Salvage work shall be considered incidental to the lump sum work, and the Contractor's cost shall be included in the applicable items of work in the Proposal.

B. Contractor shall coordinate with Owner equipment and materials to be salvaged, ensuring it does not affect the critical path.

PART 6 – TEMPORARY CONSTRUCTION UTILITIES AND FACILITIES

6.01 LAYOUT OF TEMPORARY FACILITIES

A. Before starting the Work, the Contractor shall submit to the Owner their requirements for space for temporary structures and storage of materials. Should the Contractor require space in addition to that available at the jobsite, the Contractor shall make his own arrangements for storage of materials and equipment in locations other than the construction site. For the allocated space onsite, the Contractor shall submit to the Owner, for approval, the proposed plan and layout for all temporary offices, sanitary facilities, temporary construction roads, storage buildings, storage yards, temporary water service and distribution, and temporary power service and distribution. Contractor shall pay for all temporary facilities.

6.02 CONTRACTOR AND SUBCONTRACTOR'S WORK AREA

A. The Contractor and their subcontractors shall limit their operations and storage of equipment and materials to areas as directed by the Owner. The Contractor shall not disturb any areas delineated by the Owner.

B. The Contractor shall maintain the area during construction in a manner that will not obstruct operations of any existing street areas or existing plant operations. The Contractor shall proceed with their work in an orderly manner, maintaining the construction site free of debris and unnecessary equipment and/or materials.

6.03 TEMPORARY WATER

A. The Contractor will provide all temporary water required for construction. Any temporary installation shall meet all pertinent regulations. Contractor shall bear costs for temporary connection to waterlines as directed by Owner.

6.04 WATER FOR TESTING

A. The Contractor will provide the necessary water required for testing equipment prior to acceptance of the Work, unless otherwise specifically stated in the Specifications for the equipment, system, or facility. Contractor shall coordinate with the utility company for the volume and timing of when water is used. Contractor shall pay for water needed.

6.05 TEMPORARY ELECTRIC POWER

A. Contractor shall provide separate 480 volt and 120 volt power to the site for construction activities. The permanent facility power supply will be utilized for facility testing and startup.

6.06 SAFETY REQUIREMENTS FOR TEMPORARY ELECTRIC POWER

A. Temporary electric power installation shall meet the construction safety requirements of OSHA, state, and other governing agencies. This shall be the responsibility of the Electrical Subcontractor.

6.07 SANITARY FACILITIES AND DRINKING WATER

A. The Contractor shall provide chemical toilets of suitable type and shall maintain the facilities in a sanitary condition at all times. The chemical toilet shall be of watertight construction so that no contamination of the area can result from its use. The facilities shall conform to code requirements and be acceptable to the sanitary authorities. Upon completion of the Work, the sanitary facilities shall be removed and the area restored to its original condition.

B. Contractor shall provide suitable drinking water for their workers.

6.08 TEMPORARY TELEPHONE SERVICE

A. The Contractor shall furnish onsite telephone service for himself during the period of construction of the Contract, as he determines necessary.

6.09 STORAGE OF MATERIALS

A. All materials shall be stored in a manner that ensures the preservation of their quality and fitness for the Work. Private property shall not be used for storage purposes without the written permission of the Owner and property owners.

6.10 STORAGE BUILDINGS OR TRAILERS

A. If necessary, the Contractor shall erect or provide as–approved, temporary storage buildings and or trailers of the various sizes as required for the protection of equipment and materials. At or near the completion of the Work, and as directed by the Owner, the temporary storage buildings or trailers shall be dismantled, removed from the site, and remain the property of the Contractor.

B. Upon completion of the work, Contractor shall ensure the area designated for storage buildings and/or trailers is returned to its original condition and a suitable strand of grass or other approved land cover shall be provided.

C. Combustible materials (paints, solvents, fuels, etc.) shall be stored in a well–ventilated building removed from other buildings.

6.11 STORAGE YARDS

A. The Contractor shall construct temporary storage yards for the storage of materials that are not subject to damage by weather conditions. Materials such as pipe, reinforcing and structural steel, shall be stored on pallets or racks, off the ground, and stored in a manner to allow ready access for inspection and inventory. Temporary gravel surfacing of the storage yards shall meet with the approval of the Owner. Contractor shall be responsible for the security of all stored materials.

6.12 DEBRIS AND WASTE DISPOSAL FACILITIES

A. The Contractor shall provide trash and debris bins, dumpsters, and containers for proper disposal of waste material. Construction and demolition berms shall be separated from organic, paper, and office material. Contractor shall be responsible for the routine removal of trash and debris.

PART 7 – SAFETY AND CONVENIENCE

7.01 CONSTRUCTION SAFETY PROGRAM

A. The Contractor shall develop and maintain for the duration of this Contract, a Safety Plan in accordance with the provisions of the Contract and applicable regulatory requirements.

B. The Owner shall review the Contractor's performance and compliance with the Safety Plan and retain an appropriate amount (up to TEN percent) of each pay request for noncompliance. The following component will be reviewed as a minimum:

1. Tool box locks.
2. Daily pre–task planning.
3. Task hazard analysis.
4. Equipment assessment checklist.
5. Housekeeping.

6. Use of personal protective equipment.
7. Safe working habits.
8. Weekly, jobsite specific, site inspections.

C. The duty of the Owner to conduct construction review of the Contractor's performance is not intended to include a review or approval of the adequacy of the Contractor's safety supervisor, the Safety Plan, or any safety measures taken in, on, or near the construction site. The contractor is responsible for all compliance.

7.02 SAFE ACCESS BY FEDERAL, STATE, AND LOCAL GOVERNMENT OFFICIALS

A. Authorized government officials shall, at all times, have safe access to the work, and the Contractor shall provide proper facilities for such access and Inspection.

7.03 TRAFFIC MAINTENANCE AND SAFETY

A. The Contractor shall comply with all rules and regulations of the state, county, and city authorities with regard to closing or restricting the use of public streets or highways. No public or private road shall be closed, except by express permission of the Owner and the City. Contractor shall conduct the Work so as to impose the least possible obstruction to traffic and normal commercial pursuits. Contractor shall protect all obstructions within traveled roadways by installing approved signs, barricades, and lights, where necessary for the safety of the public. The convenience of the general public and of residents adjacent to the Project, and the protection of persons and property are of prime importance and shall be provided for in an adequate and satisfactory manner.

7.04 PROTECTION OF PROPERTY

A. The Contractor shall protect stored materials, cultivated trees and crops, and other items located adjacent to the proposed work. Contractor shall notify property Owners affected by the construction at least one week in advance of the time construction begins. During construction operations, Contractor shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No person shall be cut off from access to their residence or place of business for a period exceeding four hours, unless the Contractor has made special arrangements with the affected persons.

7.05 FIRE PREVENTION AND PROTECTION

A. The Contractor shall perform all work in a fire–safe manner. The Contractor shall supply and maintain on the Site adequate fire–fighting equipment capable of extinguishing incipient fires. The Contractor shall comply with applicable federal, state, and local fire–prevention regulations and requirements of the City Fire Department. Where these regulations do not apply, applicable parts of the National Fire Prevention Standard for Safeguarding Building Construction Operations (NFP A No. 241) shall be followed.

7.06 ACCESS FOR POLICE, FIRE, AND POSTAL SERVICE

A. Contractor shall request approval from the fire department and police

department to close any street or portion thereof. No closing shall be made without the Owner's and these departments approval. Contractor shall notify said departments when the streets are again passable for emergency vehicles. Contractor shall not block off emergency vehicle access to consecutive arterial crossings or dead–end streets, in excess of 300 linear feet, without special written permission from the fire department. Contractor shall conduct operations with the least interference to fire equipment access, and at no time prevent such access.

B. Contractor shall maintain postal service facilities in accordance with the requirements of the Postal Service. If necessary, Contractor shall move mailboxes to temporary locations designated by the Postal Service, and at the completion of the Work in each area, replace them in their original location and in a condition satisfactory to the U.S. Postal Service.

PART 8 – TEMPORARY ENVIRONMENTAL CONTROL

8.01 NOISE CONTROL

A. Contractor shall take every action possible to minimize noise caused by construction operations. Operate in compliance with any applicable ordinances, regulations, rules and laws in effect in area pertaining to noise.

B. Provide equipment that operates with least possible noise. Provide electrically operated equipment in work area to extent possible. Equip air intake of compressors with silencers and provide machinery operated by gearing with a type of gearing designed to reduce noise to a minimum. Equip internal combustion engines with mufflers. Maintain equipment silencing features in good condition and use at all times.

C. Comply with approved work hours. Noise shall not occur prior to 8:00 AM nor later than 6:00 PM without prior written approval from the Owner.

8.02 AIR POLLUTION CONTROL

A. Contractor shall exercise every reasonable precaution to keep air pollution to a minimum throughout life of Project.

8.03 WATER CONTROL

A. Contractor shall keep excavations free from water while site grading, structural work, pipe laying, or other construction is in progress.
   1. Surface Drainage:
      a. Control drainage and stormwater in accordance with the Project stormwater pollution prevention plan. Intercept and divert upstream surface drainage away from work site by use of dikes, curb walls, ditches, pipes, sumps, or other means.

      b. Intercept and divert work site surface drainage away from excavation by use of dikes, curb wails, ditches, pipes, sumps, or other means.

c. Design surface drainage systems so they do not cause erosion on or offsite or cause unwanted flow of water.

d. Remove surface drainage system when no longer required.

e. Remove debris and restore site to original condition.

2. Dewatering:

a. All dewatering activities shall meet the requirements of the Site Dewatering Permit and the Owner. Dewatering shall not flood any adjacent or downstream property.

b. Subsurface (groundwater) elevations and storm water runoff vary with the time of year and rainfall amounts across the limits of construction as defined on the Contract Drawings. Neither the Engineer no the Owner can accurately estimate the water elevations that may be encountered during performance of Work.

c. The Contractor shall be responsible for dewatering areas as deemed necessary by the Contractor to allow for the proper construction of the Project and all appurtenances.

d. The Contractor shall at all times during performance of the Work provide and maintain proper equipment and facilities to remove water entering excavations. The Contractor shall keep such excavations dry so as to obtain a satisfactory foundation condition for all Work.

e. The Contractor shall not allow water to accumulate in excavations. The Contractor shall remove water to prevent softening of the foundation bottom and soil changes detrimental to stability of sub grades and foundations. Sub grade soils which become soft, loose, quick, or otherwise unsatisfactory for support of structure as a result of inadequate dewatering or other construction methods shall be removed and replaced by crushed stone as required by the Consultant at the Contractor's expense. The bottom of excavations shall be firm and without standing water before placing structures or pipes. The Contractor shall provide and maintain pumps, well points, sumps suction and discharge lines, and other dewatering system components deemed necessary by the Contractor to convey water away from excavations.

f. The Contractor shall establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water away from the excavations to collecting or runoff areas. The Contractor shall not use trench excavations as temporary drainage ditches.

g. See Section 31 23 19.01 Dewatering.

8.04 DEBRIS CONTROL

A. The Contractor shall proceed with construction cleanup on a daily basis, as construction progresses. Cleanup consists of removal of mud, oil, grease, trash, used forms, scrap, debris, excess material, and any other items that are unsightly or can cause the tripping or slipping of workmen, ladders, or equipment.

B. Dispose of construction waste material in an authorized disposal area.

8.05 POLLUTION CONTROL

A. Contractor shall take precautions in conduct of operations as necessary to avoid contaminating water in adjacent water sources or water impoundments such as lakes, reservoirs, ditches, waterways, ponds, etc. Do not discharge pollutants such as chemicals, fuels, lubricants, bitumens, raw sewage, and other harmful waste into or alongside streams, impoundments, or into natural or man–made channels leading to them. Do not discharge water used during work on Project that has become contaminated into rivers, streams, ditches, or impoundments.

B. Conduct all earthwork, moving of equipment, water control of excavations or other operations likely to create silting, so as to minimize pollution of rivers, streams, ditches, and impoundments. Do not deposit excavated material in or so near to rivers, ditches, streams, or impoundments that it will be washed away by high water or runoff.

C. Contractor shall not dispose of or wash any equipment or other items in the ocean, Intracoastal Waterway or adjacent ditches.

8.06 EROSION CONTROL

A. Contractor shall use proper and acceptable methods of soil erosion and sedimentation control for exposed earthwork and assume obligation for fines and related costs resulting from failure to provide adequate protection against soil erosion.

8.07 LIGHT CONTROL

Contractor shall not allow work light used during darkness to shine into adjacent properties. Contractor shall obtain prior written approval from Owner before working at night and using work lights.

PART 9 – PRESERVATION, RESTORATION, AND CLEANUP

9.01 SITE RESTORATION AND CLEANUP

A. At all times during the Work, Contractor shall keep the premises clean and orderly, and upon completion of the Work, repair all damage caused by equipment and leave the project free of rubbish or excess materials of any kind.

B. Contractor shall stockpile excavated materials in a manner that will cause the least damage to adjacent lawns, grassed areas, gardens, shrubbery, or fences,

regardless of whether these are on private property, or on state, county, or city right–of–ways. Install silt fence around stock piles to prevent erosion. Install covering as necessary to prevent blown movement. Remove all excavated materials from grassed and planted areas, and leave these surfaces in a condition equivalent to their original condition.

C. All existing drainage ditches and culverts shall be reopened, graded, stabilized, and natural drainage restored, unless otherwise indicated on the Drawings. Contractor shall restore culverts, broken or damaged, to their original condition and location.

9.02 TREE REMOVAL

A. Trees and other natural vegetation shall not be removed or disturbed in those areas designated on the Drawings to remain, disturbed or as indicated by the Contractor. Trees removed in other areas of the site shall be disposed of off the Worksite by the Contractor.

9.03 DUST PREVENTION

A. Contractor shall give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust–preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced.

9.04 PRESERVATION OF IRRIGATION AND DRAINAGE DITCHES

A. Arrange schedules so that construction will not interfere with the irrigation of cultivated lands, pasturelands or landscaped areas. Construction may proceed during the irrigation season, provided the Contractor constructs, at Contractor's own expense, temporary irrigation ditches, turnouts, and miscellaneous structures acceptable to the owner of the property.

B. After backfilling of the trenches, restore storm drain ditches destroyed, damaged, or otherwise modified during construction, to a condition equivalent, in the opinion of the Contractor, to the condition of the ditch before construction, or as shown on the Drawings. Ditches so reconstructed shall be built in their original locations.

9.05 DISPOSAL OF WASTE MATERIALS

A. All suitable material, including soil material if excavated during construction, meeting the Project Specifications shall be reused and incorporated into the Project or stock piled in a location noted by the Owner.

B. An on-site disposal area will be provided by the Contractor for the Contractor's use for disposal of waste materials. Waste materials shall be removed from the site prior to substantial completion.

C. The Contractor shall be responsible for loading and transporting waste materials to a suitable disposal area. At no time shall excavated waste be stockpiled adjacent to the excavations.

PART 10 – SUBMITTALS DURING CONSTRUCTION

10.01 GENERAL

A. Requirements in this Section are in addition to any specific requirements for submittals specified in other Sections of these Specifications and the Contract.

B. Method for delivery of submittals to Engineer shall be coordinated and agreed upon with Engineer. Assume delivery (via mail or hand delivery) of hard copies of the submittals will be required.

C. Submitted data shall be fully sufficient in detail for determination of compliance with the Contract Documents. Coordinate submittal numbering and submittal schedule with Engineer immediately following execution of the Contract.

D. Review, acceptance, or approval of substitutions, schedules, Shop Drawings, lists of materials, and procedures submitted or requested by the Engineer shall not add to the Contract amount, and all additional costs which may result therefrom shall be solely the obligation of the Contractor.

E. The Owner is not precluded, by virtue of review, acceptance, or approval, from obtaining a shared credit for construction savings resulting from allowed concessions in the Work or materials thereof.

F. It shall not be the responsibility of the Owner to provide engineering or other services to protect the Contractor from additional costs accruing from such approvals.

G. No equipment or material for which listings, drawings, or descriptive material is required shall be installed until the Contractor has received approved copies of the Shop Drawings.

H. No "Or Equal" material or equipment shall be installed without approval by the Engineer.

I. The review of drawings by the Engineer will be limited to general design requirements only, and shall in no way relieve the Contractor from responsibility for errors or omissions contained therein.

J. Submittals will be acted upon by the Engineer as promptly as possible, and returned to the Contractor not later than the time allowed for review in Paragraph Shop Drawing Submittal Procedure. Delays caused by the need for resubmittals shall not constitute reason for an extension of Contract time.

K. The Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment or method of work shall be as described in the submittal. The Contractor shall verify that all features of all products conform to the specified requirements. Submittal documents shall be clearly edited to indicate only those items, models, or

series of equipment, which are being submitted for review. All extraneous materials shall be crossed out or otherwise obliterated. The Contractor shall ensure that there is no conflict with other submittals and notify the Construction Manager in each case where his submittal may affect the work of another contractor or the Owner. The Contractor shall coordinate submittals among his subcontractors and all suppliers.

The Contractor shall coordinate submittals with the work so that work will not be delayed. He shall coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals. The Contractor shall not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment shall be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."

The Contractor shall certify on each submittal document that he has reviewed the submittal, verified field conditions, and complied with the contract documents.

10.02 SHOP DRAWING SUBMITTAL PROCEDURE

A. The Contractor or vendor shall submit a minimum of two hard copies and one electronic file in Portable Document Format (PDF), to the Engineer for review. Contractor and Engineer may alter submittal requirement based upon method of submittals and approvals agreed upon. Submittals shall be made with sufficient time to allow the Engineer not less than fifteen regular working days for examining each submittal or resubmittal.

B. If the technical content of any submittal deviates from the designs or requirements stated in the Specifications or Drawings, a letter shall accompany it explaining, in detail, the reason for each deviation.

C. Hard copies of submittals shall be legible and intact.

D. Each submittal shall have a package and submittal number that will correspond to the specification section. Coordinate numbering with Engineer before making first submittal.

E. Shop Drawings shall be accurate, distinct, and complete, and shall contain all required information, including satisfactory identification of items, units, and assemblies in relation to the Contract Drawings and Specifications.

F. Shop Drawings shall be submitted only by the Contractor and manufacturer/vendor/supplier, who shall indicate by a signed stamp on the Shop Drawings, or other approved means, that the Contractor has checked and approved the submittal, that the contents are in accordance with Contract requirements, and that the submittal has been checked for dimensions and relationship with work of all other trades involved. The practice of submitting incomplete or unchecked Shop Drawings for the Engineer to correct or finish will not be acceptable. Shop Drawings which, in the opinion of the Engineer, have not been checked by the Contractor will be considered as not complying with

the intent of the Contract Documents and will be returned to the Contractor for resubmission in the proper form.

G. When the Shop Drawings have been reviewed by the Engineer, two sets of the submittal will be returned to the Contractor appropriately stamped. If major changes or corrections are necessary, the shop drawing may be rejected and one set will be returned to the Contractor with such changes or corrections indicated, and the Contractor shall correct and resubmit the Shop Drawings in the same manner and quantity as specified for the original submittal, unless otherwise directed by the Engineer. If changes are made by the Contractor (in addition to those requested by the Engineer) on the resubmitted Shop Drawings, such changes shall be clearly explained in a transmittal letter accompanying the resubmitted Shop Drawings and as noted on the submittal.

H. The review of such Shop Drawings and catalog cuts by the Engineer shall not relieve the Contractor from responsibi1ity for correctness of dimensions, fabrication details, and space requirements, or for deviations from the Contract Drawings or Specifications. Review by the Engineer shall not relieve the Contractor from the responsibility for errors in the Shop Drawings.

I. The Contractor agrees that shop drawing submittals processed by the Engineer do not become Contract Documents and are not Change Orders; that the purpose of the Shop Drawing review is to establish a reporting procedure and is intended for the Contractor's convenience in organizing their work and to permit the Engineer to monitor the Contractor's progress and understanding of the design.

10.03 SHOP DRAWING REQUIREMENTS

A. Shop Drawings referred to herein shall include Shop Drawings and other submittals for both shop and field–fabricated items. The Contractor shall submit, as applicable, the following for all prefabricated or manufactured structural, mechanical, electrical, plumbing, process systems, and equipment:

1. Shop Drawings or equipment drawings, including dimensions, size and location of connections to other work, and weight of equipment.

2. Catalog information and cuts.

3. Installation or placing drawings for equipment, drives, and bases.

4. Supporting calculations for equipment and associated supports specified to be designed by equipment manufacturers or suppliers.

5. Complete manufacturer's specifications, including materials description and paint system.

6. List of materials and supplies required for the equipment prior to, and during startup.

7. List of materials and supplies furnished with the equipment.

8. Samples of finish colors for selection.

9. Special handling instructions.

10. Requirements for routine maintenance required prior to plant startup.

11. List of all requested exceptions to the Contract Documents.

12. Operation and Maintenance Manuals for any equipment furnished.

B. The submittals shall include satisfactory identification of items, units, and assemblies in relation to the Specification section number, and the system or equipment identification or tag number shown on the Drawings, the Process and Instrumentation Diagram (P&ID), or as provided in the applicable Specification section.

C. Should the Contractor propose any item on their Shop Drawings, or incorporate an item into the Work, and that item should subsequently prove to be defective or otherwise unsatisfactory, regardless of the Engineer's preliminary review, the Contractor shall, at the Contractor's own expense, replace the item with another item that will perform satisfactorily.

10.04 RECORD DRAWINGS

A. The Contractor shall prepare a set of Record Drawings for the Project which will include the changes made in materials, equipment, locations, and dimensions of the Work. Each month, or as otherwise agreed, the Contractor shall submit to the Engineer a current listing and description of each change incorporated into the Work since the preceding submittal. The Contractor shall maintain a set of Record Drawings onsite and shall update the Drawings on a weekly basis. Changes shall be identified in red on the plans.

B. Contractor shall provide project record drawings to the Owner and Engineer accurately depicting the finished work.

10.05 SUBMITTAL OF INTERFACE INFORMATION CONNECTION AND RELATIONSHIP WITH OTHER WORK

A. Where called for on the Specifications and as determined necessary by the Contractor, interface information shall be submitted as specified. This interface information shall be accurate, and contain all information necessary to allow the completion of detailed design and construction of the interfacing or connecting work. The Contractor shall include in their negotiation for Contract work, such agreements as may be necessary to ensure the accuracy of Contractor's interface submittal information. In the event additional costs are incurred due to subsequent changes to information given in said interface information, such additional costs shall be borne by the Contractor.

10.06 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The Contractor or Vendor shall furnish eight hard copies and one electronic version of a complete instruction manual for installation, operation, maintenance, and lubrication requirements for each component of mechanical and electrical

equipment or system provided. All equipment manufacturers and suppliers shall be made aware of these requirements and all associated costs shall be included in the costs for furnishing the equipment or system. Each instruction manual furnished shall be fixed in hard–back cover, which is clearly labeled to designate the system or equipment for which it is intended with reference to the building and equipment number, and the Specification section where the item is specified.

B. Electronic versions shall be submitted in PDF format on a CD properly labeled to designate the system or equipment for which it is intended with reference to the building and equipment number, and the Specification section where the item is specified.

C. See Section 01 78 23 Operating and Maintenance Information for additional requirements.

10.07 SPARE PARTS AND SPECIAL TOOLS

A. As required for each item of equipment, and as specified in corresponding Specification Sections.

B. All equipment, spare parts, and special tools provided by Contractor or Vendor, 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. Parts shall be numbered and named in accordance with the Operation and Maintenance Manual identification system.

C. Contractor or Vendor shall also supply a list of recommended spare parts in addition to those required by the Specifications.

D. Use the "Transfer Form" which can be found in Section 01 99 90 Reference Forms, to document the transfer of spare parts and special tools to the Owner.

10.08 EQUIPMENT IDENTIFICATION PLATES AND TAGS

A. Provide manufacturer's standard equipment identification plate, securely mounted on each separate equipment component with manufacturer, model number, serial number, and any other information required to obtain service or replacement parts from manufacturer.

B. Provide a 16–gauge, Type 316 stainless steel equipment tag, 3–inch minimum diameter, securely mounted to each item of equipment using stainless steel wire rope and crimps or other approved mounting method by the Engineer. Tag shall have 3/8–inch high engraved type black enamel filled letters with the equipment name and number as shown on the P&ID Drawings.

10.09 SAMPLES AND TEST SPECIMENS

A. Where required in the Specifications, and as determined necessary by the Contractor, test specimens or samples of materials, appliances, and fittings to be used or offered for use in connection with the Work shall be submitted to the Owner at the Contractor's expense, with information as to their sources, with all cartage charges prepaid, and in such quantities and sizes as may be required for proper examination and tests to establish the quality or equality thereof, as applicable.

B. All samples and test specimens shall be submitted in ample time to enable the Engineer to make any tests or examinations necessary, without delay to the Work. The Contractor will be held responsible for any loss of time due to Contractor's neglect or failure to deliver the required samples to the Owner, as specified.

C. Samples for testing shall be taken during the course of the Work, as required by the Owner.

D. Laboratory tests and examinations that the Owner elects to make in its own laboratory will be made at no cost to the Contractor, except that, if a sample of any material or equipment proposed for use by the Contractor fails to meet the Specifications, the cost of testing subsequent samples shall be borne by the Contractor.

E. All tests required by the Specifications to be performed by an independent laboratory shall be made at the sole expense of the Contractor.

F. Material used in the Work shall conform to the submitted samples and test certificates as approved by the Engineer.

10.10 CERTIFICATES OF COMPLIANCE WITH SPECIFIED STANDARDS AND CODES

A. Certificate of Compliance shall be furnished for materials specified to a recognized standard or code prior to the use of such materials in the Work. The Engineer may permit the use of certain materials or assemblies prior to sampling and testing if accompanied by a Certificate of Compliance. The certificate shall be signed by the manufacturer of the material or the manufacturer of assembled materials, and shall state that the materials involved comply in all respects with the requirements of the Specifications. A Certificate of Compliance, clearly identifying what it represents, shall be furnished with each lot of material delivered to the site.

B. All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the Contractor of the responsibility for incorporating material in the Work which conforms to the requirements of the Contract Documents. Any such material not conforming to such requirements will be subject to rejection whether in place or not.

C. The Owner reserves the right to refuse permission for use of material on the basis of a Certificate of Compliance.

D. The form of the Certificate of Compliance and is disposition shall be as directed by the Owner.

10.11 CERTIFICATES OF DESIGN

A. Where required in the Specifications, Contractor or his subcontractors or vendors shall provide engineering design services by a professional engineer licensed in the State of South Carolina.

B. Where engineering design services are required by the Specifications, Subcontractor or Vendor shall provide signed and sealed documents.

10.12 PHOTOGRAPHIC DOCUMENTATION

A. Includes requirements for the following:
   1. Preconstruction photographs.
   2. Periodic construction photographs.
   3. Final completion construction photographs.

B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

C. Digital Photographs: Submit image files within three business days of taking photographs.
   1. Digital Camera: Minimum sensor resolution of 12 megapixels.

   2. Format: Minimum 3,200 by 2,400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, 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. Name and contact information for photographer.
      c. Name of Engineer.
      d. Name of Contractor
      e. Date photograph was taken.
      f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
      g. Unique sequential identifier keyed to accompanying key plan.

D. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3,200 by 2,400 pixels.

E. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

1. Date and Time: Include date and time in file name for each image.

2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect/Engineer.

F. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Engineer.

1. Flag construction limits before taking construction photographs.

2. Take at least 25 photographs to show existing conditions adjacent to property before starting Work.

3. Take at least 40 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.

4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

G. Final Completion Construction Photographs: Take at least 30 color photographs after date of Substantial Completion for submission as project record documents. Engineer will inform photographer of desired vantage points.
1. Do not include date stamp.

10.13 MONTHLY PROJECT STATUS REPORT

Prepare a monthly project status report including the following:
1. Current status of Project:
   a. Schedule.
   b. Cost.
   c. MBE and WBE participation, as applicable.
   d. RFI's.
   e. Submittals.
   f. Manpower.
   g. Safety.

2. Narrative of progress achieved in previous month, activities anticipated for the next month, and issues affecting the rate of progress.

PART 11 – TESTING, CHECKOUT, AND STARTUP SERVICES

11.01 GENERAL

A. The Contractor shall test and check out all systems furnished or installed by the Subcontractor. Piping and valves shall be pressure tested and point–to–point continuity tests shall be completed for wiring. See detailed specifications for testing and checkout requirements.

B. During testing, problems arising from the Contractor's errors and omissions shall be

corrected by the Contractor at their own expense.

C. The Contractor shall inform the Owner at least five days in advance of when testing will be performed.

D. The Contractor shall be present during startup to assist in any repairs that may be necessary.

PART 12 – MANUFACTURER'S SERVICES DURING CONSTRUCTION

12.01 GENERAL

A. Competent and experienced technical representatives shall represent the manufacturers of all equipment and systems as may be necessary to resolve assembly, equipment malfunctioning, controls problems, or installation problems at the Worksite which are attributable to, or associated with, the equipment furnished.

B. Provide the minimum number of person–days and trips to the Site specified in the individual Specification sections. These person–days are for the services specified and are not for resolving problems associated with installation, testing, or startup of systems or equipment that are due to deficiencies in the supplied system, equipment, or their associated installation, operation or maintenance instructions and manuals.

12.02 MANUFACTURER'S CERTIFICATION

A. Manufacturer's representative shall certify in writing that the equipment has been inspected by a Manufacturer's authorized representative, installed in accordance with the manufacturer's recommendations, been serviced with the proper initial lubricants, that applicable safety equipment has been properly installed and that the proper electrical and mechanical connections have been made. Certificate of Proper Installation & Startup for documentation shall be forwarded to Engineer upon completion.

12.03 INSTALLATION ASSISTANCE AND INSPECTION

A. The appropriate manufacturer's representative shall be present to instruct the Contractor and Subcontractor on the proper installation procedures for the specified system or equipment. The manufacturer's representative will also inspect the ongoing installation activities to confirm that they meet all manufacturers' recommendations.

12.04 FUNCTIONAL TESTING

A. The appropriate manufacturer's representative spall be present and assist with the initial test, which shall include, but not be limited to, checking for proper rotation, alignment, speed, excessive vibration, and noisy operation. Initial equipment, system adjustment and calibrations shall be performed in the presence of the Engineer, and with the assistance of the manufacturer's representative. The above–mentioned manufacturer's certification shall include the statement that

proper adjustments have been made, and that the equipment or system is ready for plant startup and operation.

B. Where the manufacturer's system or equipment includes instrumentation and controls, use forms in Section 01 99 90 Reference Forms to document proper installation, calibration, and testing.

12.05 OPERATIONAL READINESS TEST (ORT) ASSISTANCE

A. The appropriate manufacturer's representative shall be present to assist the Process Instrumentation and Control Systems (PICS) Supplier with the ORT in accordance with Process Instrumentation and Control Systems (PICS). This assistance shall include confirmation of all signals between the manufacturer's system or equipment and the PICS, as well as confirmation of proper operation of all controls internal to the manufacturer's system or equipment.

12.06 SERVICES DURING PERFORMANCE TESTING AND PLANT STARTUP

A. Where plant startup services are called for in the Specifications, or when technical assistance is necessary due to any malfunction of the equipment furnished, the manufacturer's representative shall furnish such services. The manufacturer's representative shall also assist with final performance and demonstration testing, as required by the Specifications. These services shall continue until such times as the applicable equipment has been successfully performance tested and has been accepted by the Owner and Engineer for full–time operation. Use the attached Supplement—7, Performance Acceptance Test Sheet for documentation and forward to Owner upon completion.

12.07 TRAINING OF OWNER'S PERSONNEL

A. The manufacturer's representative shall furnish detailed instructions to the Owner's personnel for operation of the specified equipment. These training services shall include pre–startup classroom, onsite equipment instruction, and post–startup classroom, as stated in the Specifications.

B. The training session shall include theory, as appropriate, as well as specific operation and maintenance requirements. Training shall include both classroom and field training sessions. Training session time shall be acceptable to the Owner for staff to attend. Training handouts shall be prepared for each attendee. An electronic version of the handout shall be submitted to the Engineer at least one week prior to the training.

12.08 SUPPLEMENTS

A. The supplements and reference forms listed in Section 01 99 90 Reference forms are part of this Specification.

End of Section

INDEX TO

SECTION 01 15 00

CONTROL OF WORK

SECTION 01 15 00

CONTROL OF WORK

PART 1 – GENERAL

1.01 WORK PROGRESS

A. The Contractor shall furnish personnel and equipment which will be efficient, appropriate and adequately sized to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time stipulated in the Contract. If at any time such personnel appears to the Engineer to be inefficient, inappropriate, or insufficient for securing the quality of work required for producing the rate of progress aforesaid, he may advise the Contractor to increase the efficiency, change the character, or increase the personnel and equipment and the Contractor shall conform to such order at no additional cost to the Owner. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.02 PRIVATE LAND

A. The Contractor shall not enter or occupy private land outside of easements, except by permission of the adjacent property owner and Owner. A copy of the written consent shall be given to the Engineer.

1.03 WORK LOCATIONS

A. Work shall be located substantially as indicated on the drawings, but the Owner and Engineer reserve the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons.

1.04 PIPE LOCATIONS

A. Exterior pipelines will be located substantially as indicated on the Drawings, but the right is reserved to the Owner, acting through the Engineer, to make such modifications in location as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings, etc., are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

B. Small interior piping is indicated diagrammatically on the Drawings, and the exact location is to be determined in the field. Piping shall be arranged in a neat, compact, and workmanlike manner, with a minimum of crossing and interlacing, so as not to interfere with equipment or access ways, and, in general, without diagonal runs.

1.05 DIMENSION OF EXISTING STRUCTURES

A. Where the dimensions and locations of existing structures are of importance in the installation or connection of any part of the Work, the Contractor shall verify such

dimensions and locations in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

1.06 OPEN EXCAVATIONS

A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access to private property during construction shall be removed when no longer required. If the excavation becomes a hazard, or if it excessively restricts traffic at any point the Owner may require special construction procedures such as limiting the length of open trench, prohibiting stacking excavated material in the street, and requiring that the trench shall not remain open overnight at no additional cost.

B. The Contractor shall take precautions to prevent injury to the public and employees due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be barricaded and well lighted at all time when construction is not in progress.

1.07 DISTRIBUTION SYSTEMS AND SERVICES

A. The Contractor shall avoid interruptions to power, water, telephone, communications, cable TV, sewer, gas, or other related utility services. He shall notify the Owner and the appropriate agency well in advance of any requirement for dewatering, isolating, or relocating a section of a utility, so that necessary arrangements may be made. The contractor shall coordinate all such arrangements.

B. If it appears that utility service will be interrupted for an extended period, the Contractor shall provide temporary service lines at the Contractor's expense. Inconvenience of the users shall be kept to the minimum, consistent with existing conditions. The safety and integrity of the systems are of prime importance in scheduling work.

1.08 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

A. The Contractor shall assume full responsibility for the protection of all buildings, structures and utilities, public or private, including poles, signs, services to building utilities, gas pipes, water pipes, hydrants, sewers, drains and electric, communications, cable and telephone cables and other similar facilities, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operation shall be repaired by the Contractor at his expense.

B. The Contractor shall bear full responsibility for obtaining locations of all underground structures and utilities (including existing water services, drain lines and sewers). Services to buildings shall be maintained and all costs or charges resulting from damage thereto shall be paid by the Contractor.

C. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be a part of the work under the Contract and all costs in connection therewith shall be included in the price established in the Bid.

D. If permanent relocation of a utility is required and is shown on the drawings, it shall be included in the contractor's base bid. The Contractor will notify the utility to perform the work as expeditiously as possible. The Contractor shall notify public utility companies in writing at least 48 hours (excluding Saturdays, Sunday and legal holidays) before excavating near their utilities.

1.09 TEST PITS

A. Contractor shall explore by test pits (or other means) for the purpose of locating and confirming underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor. Test pits shall be backfilled immediately after the utility location and the surface shall be restored in a manner equal or better than the original condition. No separate payment will be made. Report in writing finding to Engineer and Owner.

1.10 CARE AND PROTECTION OF PROPERTY

A. The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better to existing before the damage was done, or he shall make good the damage in another manner acceptable to the Owner.

B. All sidewalks and paved areas which are disturbed by the Contractor's operations shall be restored to their original or better condition by the use of similar or comparable materials. All curbing shall be restored in a condition equal to the original construction and in accordance with the best modern practice.

C. Along the location of this work, all fences, walks, bushes, trees, shrubbery, and other physical features shall be protected and restored in a thoroughly workmanlike manner unless otherwise shown on the drawings. Fences and other features removed by the Contractor shall be replaced in the same location. All grass areas beyond the limits of construction which have been damaged by the Contractor shall be regarded and sodded to equal or exceed original conditions.

D. Trees close to the work which drawings do not specify to be removed shall be fenced or otherwise protected against injury. The Contractor shall trim all branches that are liable to damage because of his operations, but in no case shall any tree be cut or removed without prior notification to the Engineer. All injuries to bark, trunk, limbs, and roots of trees shall be repaired by dressing, cutting, and painting according to approved methods, using only approved tools and materials. All work to trees shall be reformed by a licensed arborist.

E. The protection, removal, and replacement of existing physical features along the line of work or near the work shall be a part of the work under the Contract and all costs in connection therewith shall be included in the unit or lump sum prices established under the items in the Bid.

1.11 MAINTENANCE OF TRAFFIC

A. Open pits, trenches, unpaved streets, debris, or other obstructions due to construction that will prevent the normal flow of traffic during an extended construction stoppage, for any reason, shall be minimized. In the event an extended construction stoppage is found to be necessary, Contractor shall, at his own expense, provide normal traffic flow during extended construction stoppage. Extended stoppage will be defined by the Owner.

B. All excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary roadways, erect wheel guards or fences, or take other safety measures which are satisfactory to the Engineer and Owner.

C. Detours around construction areas will be subject to the approval of the Owner and the Engineer. Where detours are permitted, the Contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured will be strictly controlled by the Owner.

1.12 WATER FOR CONSTRUCTION PURPOSES

A. Owner shall provide water for construction purposes. Contractor shall comply with Owners requirement on timing, flow and pressure.

B. Owner shall provide water for hydrostatic and leakage testing one time. Subsequent water used for test shall be paid for by the Contractor.

C. Leakage tests for basins shall be performed on individual basins.

D. The Contractor shall be responsible for paying for all water needed to preform retest due to failed prior test.

1.13 MAINTENANCE OF FLOW

A. The Contractor shall at his own cost, provide for the flow of sewers, drains and water courses interrupted during the progress of the work and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer and Owner well in advance of the interruption of any flow.

1.14 CLEANUP

A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. He shall dispose of all residue resulting from the construction work and at the conclusion of the work, he shall

remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations and shall leave the entire site of the work in a neat and orderly condition. All areas shall be graded to drains. All disturbed areas shall be grassed. All pavement and walkways shall be cleaned.

1.15 COOPERATION WITHIN THIS CONTRACT

A. All firms or person authorized to perform any work under this Contract shall cooperate with the General Contractor and his subcontractors or trades and shall assist in incorporating the work of other trades where necessary or required.

B. Cutting and patching, drilling, and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

C. Contractor shall cooperate with MBR manufacturer.

1.16 PROTECTION OF CONSTRUCTION AND EQUIPMENT

A. All newly constructed work shall be carefully protected from injury in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions injured shall be reconstructed by the Contractor at his own expense.

B. All structures shall be protected in a manner approved by the Owner. Should any of the floors or other parts of the structures become heaved, cracked, or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor, at his own expense and to the satisfaction of the Owner. If, in the final review of the work, any defects, faults, or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation or the materials and labor required.

Further, the Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the warranty period describe in the Contract.

1.17 CONSTRUCTION WITHIN RIGHT-OF-WAY

A. Where pipe lines are installed within the DOT right-of-way, all excavation backfill and compaction for the purpose of reconstructing roadways and adjacent slopes contiguous thereto shall be in accordance with the DOT or County Standards and Specifications, whichever is applicable. Contractor shall satisfy the authorized representative of the DOT with respect to proper safety procedures, construction methods, required permitting, etc., within the DOT right-of-way.

1.18 CLEANUP AND DISPOSAL OF EXCESS MATERIAL

A. During the course of the work, the Contractor shall keep the site of his operations in as clean and as neat a condition as is possible. He shall dispose of all residue resulting from the construction work and, at the conclusion of the work, shall

remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations, and shall leave the entire site of the work in a neat and orderly condition.

B. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, the Contractor and his subcontractors shall comply with all applicable Federal, State, and local laws, and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and elsewhere in the Specifications.

C. The Contractor is advised that the disposal of excess excavated material in wetlands, stream corridors, and plains is strictly prohibited even if the permission of the property owner is obtained. Any violation of this restriction by the Contractor or any person employed by him will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. Therefore, the Contractor will be required to remove the fill at his own expense and restore the area impacted.

PART 2 – PRODUCTS

None this Section.

PART 3 – EXECUTION

None this Section.

END OF SECTION

INDEX TO

SECTION 01 21 00

ALLOWANCES

SECTION 01 21 00

ALLOWANCES

PART 1 – GENERAL

1.01 SUMMARY

A. This section includes administrative and procedural requirements governing allowances.

1. Certain materials and equipment are specified in the Contract Documents by allowances. In some cases, these allowances include installation. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment and defer definition of work to a later date when additional information is available for evaluation. Allowances are also used when the exact scope, quantity or type of work product is unknown.

B. The Contractor shall include in the Base Bid Contract Sum all allowances stated in the Contract Documents. These allowances shall cover the cost of the fees, processing, licenses, materials, labor, equipment and related required items. Allowances shall include all applicable taxes. The Contractor's scheduling, handling costs on the site, unloading, uncrating, cleaning, secure storage and protection, labor, installation costs, administration, supervision, interest, bonds, insurance, all applicable taxes, overhead, profit and other related costs (including but not limited to required permits, inspections, certifications, and testing) shall be included in the Contract Base Bid and not in the allowances.

C. Amounts specified below pertain to all applicable costs.

D. The Contractor shall provide a copy of all paid invoices with the description of the work performed or fees paid for applicable allowance items, to the Owner, with monthly Pay Request Application.

E. All allowances shall be included in the Base Bid.

F. Contractor is responsible for losses incurred from allowance items that are damaged while under his care, such as while stored or during installation.

G. Owner may adjusted individual allowance amounts by transferring an amount between allowances if needed. Written confirmation is required to transfer limit amount.

1.02 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, Contractor shall advise Engineer in writing of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the work.

B. Include all allowances and the dates when a decision on an allowance is needed from Owner in project schedule. The Contractor's schedule should account for the time required to obtain competitive prices.

C. At Engineer's request, Contractor shall obtain proposals for each allowance for use in making final selections. Proposals shall include recommendations that are relevant to performing the work.

D. Purchase products and systems selected or approved by Owner and Engineer from the designated supplier.

1.03 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the forms specified for Change Orders.

B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

1.04 UNUSED MATERIALS

A. Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.

1. If requested by Engineer, prepare unused material for storage by Owner when it is not economically practical to return the material for credit. If directed by Engineer, deliver unused material to Owner's storage space. Otherwise, disposal of unused material is Contractor's responsibility.

2. If allowance is not used in whole or in part, the Owner shall remove an allowance from the construction contract by change order based on the value listed for the associated unit price.

1.05 COORDINATION

A. Coordinate allowance items with other portions of the work. Furnish templates as required to coordinate installation.

1.06 ADJUSTMENT OF ALLOWANCE COSTS

A. General

1. If the cost, when determined, is more or less than the allowance, the Contract Sum shall be adjusted accordingly by change order, which will include overhead and profit for any increase or decrease from the original allowance. The Contractor is not entitled to all or any part of an unexpended balance of the allowance.

B. Documentation

1. Submit documentation for costs or other expenses under the allowance, within ten days after completion of execution of the work or when requested by Engineer prior to execution of the work.

2. Failure to submit claims within the designated time will constitute a waiver of claims for additional costs.

3. At contract closeout, reflect all approved changes in contract amounts in the final statement of accounting.

PART 2 – SCHEDULE OF CASH ALLOWANCES

All allowances noted below shall be included in the Lump Base Sum bid amount.

2.01 UTILITY RELOCATION FEES

Allow $10,000.00 to pay utility company or companies for providing or removing and replacing as necessary or relocating existing power, telephone, or communication lines to accommodate the work that is not specifically shown on the drawings. Utilities to be relocated or replaced shown on the drawings shall be included in the Contractor's base bid, but not in the allowance.

2.02 CONTINGENCY ALLOWANCE:

Include in the contract lump sum price a contingency allowance in the amount of $30,000.00 as a contingency amount to be used only at the direction of the Owner.

2.03 WORK NOT INCLUDED IN ALLOWANCE ITEMS:

All utilities noted on the plans to be relocated shall not be included in the allowance item. Also, utilities damaged during construction shall not be considered an Allowance item. Any work noted on plans shall not be included in the allowance. All testing required by the specification shall not be included in the allowance.

PART 3 – EXECUTION

3.01 PREPARATION

A. Contractor shall examine products covered by an allowance promptly upon delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

B. Contractor shall coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

END OF SECTION

INDEX TO

SECTION 01 30 00

SPECIAL PROJECT PROCEDURES

SECTION 01 30 00

SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.01 PERMITS AND BUSINESS LICENSES

A. Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the Owner to do the work from the appropriate governmental agency or agencies and applicable business licenses. These permits include but are not limited to a SC Contractors License and local building permit and related. No work shall commence until all applicable permits and licenses have been obtained and copies delivered to the Engineer. The costs for obtaining all permits and licenses shall be borne by the Contractor.

1.02 CONNECTIONS TO EXISTING SYSTEM

A. The Contractor shall perform all work necessary to locate, excavate and prepare for connections to the terminus of the existing systems all as shown on the Drawings or where directed by the Owner or Engineer. The cost of this work and for the actual connection to the existing systems shall be included in the price bid for the project and shall not result in any additional cost to the Owner.

1.03 RELOCATIONS

A. The Contractor shall be responsible for the coordination of the relocation or protection of structures, including but not limited to light poles, power poles, signs, sign poles, fences, piping, conduits, and drains that interfere with the positioning of the work as set out on the Drawings. No relocation of the items under this Contract shall be done without approval from the Engineer.

1.04 EXISTING UNDERGROUND PIPING, STRUCTURES, AND UTILITIES

A. The attention of the Contractor is drawn to the fact that during excavation, the possibility exists of the Contractor encountering various water, sewer, gas, telephone, communication, electrical, or other utility lines now shown on the Drawings. The Contractor shall exercise extreme care before and during excavation to locate and flag these lines so as to avoid damage to the existing lines. Cost for relocation of <u>all</u> existing lines shall be included in the price bid for the project. Should damage occur to an existing line, the Contractor shall bear the cost of all repairs.

B. It is the responsibility of the Contractor to ensure that all utility or other poles, the stability of which may be endangered by the close proximity of excavation, are temporarily stayed in position while work proceeds in the vicinity of the pole and that the utility or other companies concerned be given reasonable advance notice of any such excavation by the Contractor.

C. The existing utility locations are shown without express or implied representation, assurance, or guarantee that they are complete or correct or that they represent

a true picture of underground piping to be encountered. The Contractor shall be responsible for notifying the various utility companies to locate their respective utilities in advance of construction in conformance with all requirements provided for in the State and local requirements.

D. The existing piping and utilities that interfere with new construction shall be rerouted as shown, specified or required. Before any piping and utilities not shown on the Drawings are disturbed, the Contractor shall notify the Engineer of the location of the pipeline or utility as directed. Cost for relocation of existing pipelines or utilities shall be included in the price bid for the project.

E. The Contractor shall exercise care in any excavation to locate all existing piping and utilities. All utilities which do not interfere with complete work shall be carefully protected against damage. Any existing utilities damaged in any way by the Contractor shall be restored or replaced by the Contractor at his expense as directed by the Owner and the owner of the utility.

F. Contractor shall protect existing structures to remain and shall not interrupt existing plant operation without prior Owner approval and coordination.

1.05 HURRICANE AND INCLEMENT WEATHER PREPAREDNESS PLAN

A. During hurricane season the Contractor shall submit to the Engineer and Owner a Hurricane Preparedness Plan. The plan should outline the necessary measures which the Contractor proposes to perform at no additional cost to the Owner in case of a hurricane watch and subsequent plan for a hurricane warning and finally for an evacuation.

B. In the event of inclement weather, or whenever Engineer shall advise, Contractor shall insure that he and his Subcontractors shall carefully protect work and materials against damage or injury from the weather. If, in the opinion of the Owner, any portion of work or materials is damaged due to the failure on the part of the Contractor or Subcontractor to protect the work, such work and materials shall be removed and replaced at the expense of the Contractor.

1.06 POWER SUPPLY

A. Electricity as may be required for construction and permanent power supply shall be secured and purchased by the Contractor.

1.07 DEWATERING

A. The Contractor shall conduct groundwater pumping necessary to prevent flotation of any part of the work during construction operations with his own equipment.

B. The Contractor shall pump out water and wastewater which may seep or leak into the excavations for the duration of the Contract and with his own equipment. He shall dispose of this water in an appropriate manner, without causing any siltation of downstream acres or drainage facility.

C. Contractor shall dewater as needed to perform the work or conduct testing at no additional cost to the Owner.

1.08 PUBLIC NUISANCE

A. The Contractor shall not create a public nuisance including but not limited to encroachment on adjacent lands, flooding of adjacent lands, excessive noise or dust, soil vibration or working outside the hours of 8:00 AM to 5:00 PM or working on Saturday and Sunday except by prior approval.

B. Sound levels must meet local ordinances and be no more than 90dBA. No exposure over OSHA regulations is allowed. Sound levels in excess of such are sufficient cause to have the work halted until equipment can be quieted to these levels. Work stoppage by the Owner or regulatory agency for excessive noise shall not relieve the Contractor of the other portions of this specification including, but not limited to, contract time and contract price.

C. Contractor shall continually monitor during the life of the activity vibration from pile driving, soil vibration and similar compaction. Soil vibration activities measurable vibration outside the project site boundary is not allowed. Contractor shall submit monitoring results to Owner and Engineer.

D. No extra charge may be made for time lost due to work stoppage resulting from the creation of a public nuisance.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

INDEX TO

SECTION 01 31 00

ADMINISTRATIVE REQUIREMENTS

SECTION 01 31 00

ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Coordination and project conditions.

B. Field engineering.

C. Preconstruction meeting.

D. Site mobilization meeting.

E. Progress meetings.

F. Pre-installation meetings.

1.02 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and work of various sections of specifications to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify utility requirements and characteristics of operating equipment are compatible with site utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. In finished areas, conceal pipes, and wiring within construction. Coordinate locations of fixtures and outlets with finished elements.

E. Coordinate completion and clean-up of work of separate sections in preparation for Substantial Competition. After Utility occupancy of premises, coordinate access to site and operations for correction of defective Work.

1.03 PRECONSTRUCTION MEETING

A. Engineer will schedule meeting after Notice of Award.

B. Attendance Required: Utility, Engineer, Contractor and applicable Subcontractors.

C. Agenda:

1. Submission of lists of products, schedule of values, and progress schedule.

2. Designation of personnel representing parties in Contract, Utility.

3. Procedures and processing of field decisions, submittals, and substitutions, applications for payments, proposal request, Change Orders, and Contract Scheduling.

4. Procedures for maintaining record documents.

5. Scope of Work.

1.04 SITE MOBILIZATION MEETING

A. Engineer and Contractor shall schedule meeting at Project site prior to Contractor occupancy.

B. Attendance Required: Engineer, Utility, Contractor, and major Subcontractors.

C. Agenda:

1. Utility requirements and schedule of closing the existing station during the pump replacement.

2. Construction facilities and controls.

3. Temporary utilities.

4. Survey and layout.

5. Schedules.

6. Procedures for testing.

7. Requirements for start-up of equipment.

8. Inspection and acceptance of equipment put into service during construction period.

1.05 PROGRESS MEETINGS

Schedule and administer meetings throughout progress of the Work at maximum bi-monthly intervals.

A. Make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

B. Attendance Required: Job superintendent, major subcontractors and suppliers, Utility, Engineer, as appropriate to agenda topics for each meeting.

1.06 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections, convene pre-installation meetings at Project site prior to commencing work of specific section.

B. Required attendance of parties directly affecting, or affected by, work of specific section.

C. Notify Utility, Contractor and Engineer four days in advance of meeting date.

D. Prepare agenda and preside at meeting:

1. Review conditions of installation, preparation and installation procedures.

2. Review coordination with related work.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

INDEX TO

SECTION 01 45 00

QUALITY CONTROL

SECTION 01 45 00

QUALITY CONTROL

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Quality assurance – control of installation.

B. Tolerances.

C. References and standards.

D. Testing laboratory services.

E. Manufacturer's field services.

1.02 RELATED SECTIONS

A. Section 01 00 01 – General Requirements: Preparation, Procedures, Submittals, Testing.

B. Individual Technical Specification sections: quality assurance requirements, submittals and testing procedures.

1.03 QUALITY ASSURANCE – CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturer's instructions, including each step in sequence.

C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.04 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturer's tolerances. Should manufacturer's tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions and positions before securing in place.

D. Accessible routes shall not exceed maximum ADA allowable slopes.

1.05 REFERENCES AND STANDARDS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes, or stated in the Specifications or Drawings.

B. Conform to current versions of referenced standards, except where a specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. The contractual relationships, duties, and/or responsibilities of the parties under Contract with the Owner, including those of the Engineer, shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.06 TESTING SERVICES

A. Contractor will appoint and employ services of an independent firm to perform testing. Contractor shall pay for testing services required by the specifications, except where stated otherwise for Special Inspections.

B. The independent firm will perform tests and other services specified in individual specification sections and as required by the Owner.

C. Testing and source quality control may occur on or off the project site. Perform off–site testing if required by the Specifications, Drawings, or Owner.

D. Copies of the reports will be submitted by the independent firm to the Engineer and Contractor. Reports shall indicate observations and results of tests and shall indicate compliance or non–compliance with applicable requirements.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

1. Notify Engineer and independent firm 48 hours prior to expected time for requiring sampling, testing and observation services, unless noted otherwise in the Specifications or Drawings.

2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

F. Testing does not relieve Contractor to perform Work to contract requirements.

G. Re–testing required because of non–conformance to specified requirements shall be performed by the same independent firm under the direction of the Engineer. Payment for re–testing shall be made by the Contractor.

1.07 MANUFACTURER'S FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, observe conditions of surfaces and installations, monitor quality of workmanship, provide training and instructions to operators, and provide start–up, testing, adjustment, and balancing of equipment, as applicable.

B. If a manufacturer's representative observes faulty practices on site related to or affecting their product, they shall report it immediately to the Contractor and Owner.

C. Observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions shall be documented in writing and provided to the Contractor and Engineer.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify utility services are available, of the correct characteristics, and in the correct locations.

3.02 PREPARATION

A. Prepare surfaces in accordance with the requirements of the individual technical Specification sections.

END OF SECTION

INDEX TO

SECTION 01 45 23

TESTING AND INSPECTING SERVICES

SECTION 01 45 23

TESTING AND INSPECTING SERVICES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Selection and payment.

B. Contractor submittals.

C. Testing agency responsibilities.

D. Testing agency reports.

E. Limits on testing authority.

F. Contractor responsibilities.

G. Schedule of tests.

1.02 RELATED SECTIONS

A. Testing and acceptance required by public authorities.

B. Section 01 00 00 – General Requirements: Manufacturer's certificates.

C. Section 01 77 00 – Closeout Procedures: Project record documents.

1.03 REFERENCES (LATEST REVISION)

A. ASTM C 802 – Practice for Conducting an Interlaboratory Test Program to Determine the Precision of Test Methods for Construction Materials.

B. ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

C. ASTM C 1093 – Practice for Accreditation of Testing Agencies for Masonry.

D. ASTM D 3740 – Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

E. ASTM D 4561 – Practice for Quality Control Systems for Organizations Producing and Applying Bituminous Paving Materials.

F. ASTM E 329 – Specification for Agencies Engaged in Construction Inspection and/or Testing.

G. ASTM E 543 – Practice for Agencies Performing Nondestructive Testing.

H. ASTM E 548 – Guide for General Criteria Used for Evaluating Laboratory Competence.

I. ASTM E 699 – Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

1.04 SELECTION AND PAYMENT

A. Employment and payment by Contractor for services of an independent testing agency or laboratory to perform specified testing.

B. Employment of testing agency or laboratory in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

1.05 QUALITY ASSURANCE

A. Comply with requirements of practices listed in paragraph 1.03.

B. Laboratory: Authorized to operate in State in which project is located.

C. Laboratory Staff: Maintain a full time registered Engineer on staff to review services.

D. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.

1.06 CONTRACTOR SUBMITTALS

A. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time registered Engineer and responsible officer.

B. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.

1.07 TESTING AGENCY RESPONSIBILITIES

A. Test samples of mixes submitted by Contractor.

B. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.

C. Perform specified sampling and testing of products in accordance with specified standards.

D. Ascertain compliance of materials and mixes with requirements of Contract Documents.

E. Promptly notify Engineer and Contractor of observed irregularities or non–conformance of Work or products.

F. Perform additional tests required by Engineer.

G. Attend preconstruction meetings and progress meetings.

1.08 TESTING AGENCY REPORTS

A. After each test, promptly submit three copies of report to Engineer and to Contractor.

B. Include:

1. Date issued.
2. Project title and number.
3. Name of inspector.
4. Date and time of sampling or inspection.
5. Identification of product and specifications section.
6. Location in the Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

C. When requested by Engineer, provide interpretation of test results.

1.09 LIMITS ON TESTING AUTHORITY

A. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.

B. Agency or laboratory may not approve or accept any portion of the Work.

C. Agency or laboratory may not assume any duties of Contractor.

D. Agency or laboratory has no authority to stop the Work.

1.10 CONTRACTOR RESPONSIBILITIES

A. Deliver to agency or laboratory at designated location, adequate samples of materials proposed to be used requiring testing, along with proposed mix designs.

B. Cooperate with laboratory personnel, and provide access to the Work.

C. Provide incidental labor and facilities:

1. To provide access to Work to be tested.
2. To obtain and handle samples at the site or at source of products to be tested.
3. To facilitate tests.
4. To provide storage and curing of test samples.

D. Notify Engineer and laboratory 48 hours prior to expected time for operations requiring testing services.

E. Employ services of an independent qualified testing laboratory and pay for additional samples and tests required by Contractor beyond specified requirements.

1.11 SCHEDULE OF TESTS

A. Below is a schedule of tests for the civil work. Tests related to building are elsewhere.

Section	Test	Frequency	Date	Performed By	Notes
03 30 00 – Cast–in–Place Concrete					
	Materials	As necessary			
	Mix Designs	1 per mix design			
	Strength	4 Test Cylinders for each 50 cy or less or each mix design placed daily			
	Slump	1 test per each set of cylinders			
	Air Content	1 test per each set of cylinders			
	Temperature	1 test per each set of cylinders			
31 00 00 – Earthwork					
	Compaction				
	Unpaved	1 test per horizontal layer per 10,000 sf of fill area			
	Paved	1 test per horizontal layer per 5,000 sf of subgrade			
	Building Pad	1 test per horizontal layer per 1,500 sf of fill area			
	Proof Rolling	As necessary			
32 11 23 – Aggregate Base Courses					
	Base Density	1 test per 5,000 sf			
32 12 16 – Asphalt Paving					
	Asphalt Extraction & Gradation	1 test for each 250 tons placed			
	Marshall Stability	1 test for each 250 tons placed			
	Field Density	1 test for each 250 tons placed			
	Cores	1 test for each 250 tons placed			

Water Utilities					
	Hydrostatic & Leakage	1.5 times the working pressure (no less than 150 psi). Conducted for 2 hours with maintained pressure of 150 psi (200 psi on fire main)			
	Bacteriological Samples	2 taken 24 hours apart after disinfection			
	Compaction				
	Traffic Areas	1 per 100 lf or less for each 4 ft. of depth			
	Non–Traffic Areas	1 per 500 lf or less for each 4 ft. of depth			
	Fire Flow	1 per permit			
Sanitary Sewage Utilities					
	Television Inspection of Sewers	As requested			
	Leakage	As necessary			
	Compaction				
	Traffic Areas	1 per 100 lf or less for each 4 ft. of depth			
	Non–Traffic Areas	1 per 500 lf or less for each 6 ft. of depth			
	Gravity – Air	All lines			
	Hydrostatic – Force Main	100 psi for 2 hours			
	Deflection	100% of the system			
Storm Drainage Utilities					
	Compaction				
	Traffic Areas	1 per 100 lf or less for each 4 ft. of depth			
	Non–Traffic	1 per 500 lf or less for each 6 ft. of depth			

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION

INDEX TO

SECTION 01 50 00

TEMPORARY CONSTRUCTION FACILITIES

SECTION 01 50 00

TEMPORARY CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Site Plan

1. The Contractor shall prepare a site plan indicating the proposed location and dimensions of any area to be fenced and used by the Contractor, the number of trailers to be used, avenues of ingress or egress to the fenced area and details of the fence installation. Any areas which may have to be graveled to prevent the tracking of mud shall also be identified. The Contractor shall also indicate if the use of a supplemental or other staging area is desired.

B. Identification of Employees

1. The Contractor shall be responsible for furnishing to each employee, and for requiring each employee engaged on the work to display, identification as approved and directed by the Owner. Prescribed identification shall immediately be delivered to the Owner for cancellation upon release of any employee. When required, the Contractor shall obtain and provide fingerprints of persons employed on the project. Contractor and subcontractor personnel shall wear identifying markings on hard hats clearly identifying the company for whom the employee works. All personnel shall have badges and vehicle passes or decals to enter the installation. Badges will be required to be worn at all times while on the installation.

C. Employee Parking

1. Contractor employees shall park privately owned vehicles in an area designated by the Owner. Contractor employee parking shall not interfere with existing and established parking requirements of the installation.

1.02 AVAILABILITY AND USE OF UTILITY SERVICES

A. Payment for Utility Services

1. The amount of each utility service consumed shall be charged to or paid for by the Contractor. There shall be no additional cost to the Owner.

B. Meters and Temporary Connections

1. The Contractor, at its expense and in a manner satisfactory to the Owner, shall provide and maintain necessary temporary connections, distribution lines, and meter bases required to measure the amount of each utility used for the purpose of determining charges.

C. Sanitation

1. The Contractor shall provide and maintain within the construction area minimum field-type sanitary facilities approved by the Owner. Owner toilet facilities will not be available to Contractor's personnel.

D. Telephone

1. The Contractor shall make arrangements and pay all costs for telephone facilities desired.

1.03 PROTECTION AND MAINTENANCE OF TRAFFIC

A. During construction the Contractor shall provide access and temporary relocated roads as necessary to maintain traffic. The Contractor shall maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Owner. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment and the work, and the erection and maintenance of adequate warning, danger, and direction signs, shall be as required by the State and local authorities having jurisdiction. The traveling public shall be protected from damage to person and property. The Contractor's traffic on roads selected for hauling material to and from the site shall interfere as little as possible with public traffic. The Contractor shall investigate the adequacy of existing roads and the allowable load limit on these roads. The Contractor shall be responsible for the repair of any damage to roads caused by construction operations. Any changes in traffic patterns or restrictions shall be approved by the Owner.

B. Barricades

1. The Contractor shall erect and maintain temporary barricades to limit public access to hazardous areas. Such barricades shall be required whenever safe public access to paved areas such as roads, parking areas, or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Barricades shall be securely placed, clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

1.04 CONTRACTOR'S TEMPORARY FACILITIES

A. Administrative Field Offices

1. The Contractor shall provide and maintain administrative field office facilities within the construction area at the designated site if so needed. Existing office and warehouse facilities will not be available to the Contractor's personnel. Office shall be located where it will not interfere with the progress of the work nor the Owners existing operations.

B. Storage Area

1. The Contractor shall construct a temporary six-foot high chain link fence around trailers and materials if required. The fence shall include plastic strip inserts, colored brown, so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit.

C. Appearance of Trailers

1. Trailers utilized by the Contractor for administrative or material storage purposes shall present a clean and neat exterior appearance and shall be in a state of good repair. Trailers which, in the opinion of the Owner, require exterior painting or maintenance will not be allowed on the property.

D. Maintenance of Storage Area

1. Fencing shall be kept in a state of good repair and proper alignment. Should the Contractor elect to traverse, with construction equipment or other vehicles, grassed or unpaved areas which are not established roadways, such areas shall be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways; gravel gradation shall be at the Contractor's discretion. Grass located within the boundaries of the construction site shall be mowed for the duration of the project. Grass and vegetation along fences, buildings, under trailers, and in areas not accessible to mowers shall be edged or trimmed neatly.

E. Security Provisions

1. Adequate security provisions shall be provided at the Contractor's temporary facilities. The Contractor shall be responsible for the security of its own equipment; in addition, the Contractor shall notify the appropriate law enforcement agency requesting periodic security checks of the temporary project field office.

F. Sanitary and Waste Disposal Facilities

1. The Contractor shall provide sanitary facilities for their workers, Owner, Engineer, visitors, and applicable regulatory personnel. Provide waste collections containers to handle waste from construction personal and operations.

1.05 TEMPORARY PROJECT SAFETY FENCING

A. As soon as practicable, but not later than 15 days after the date established for commencement of work, the Contractor shall furnish and erect temporary project safety fencing at the work site. The safety fencing shall be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on maximum 10 foot centers, constructed at the approved location. The safety fencing shall

be maintained by the Contractor during the life of the contract and, upon completion and acceptance of the work, shall become the property of the Contractor and shall be removed from the work site.

1.06 TEMPORARY FIRE PROTECTION

A. Install and maintain temporary fire-protections facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with Fire Department requirements.

B. Prohibit smoking in construction areas.

C. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.

D. Develop and supervise an overall fire-prevention and protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

E. Provide temporary fire protection suitable to the fire department.

1.07 PROTECTION

A. Contractor is responsible to provide such covering, shields, and barricades as are required to protect building occupants, equipment, stores, supplies, etc., from dust, debris, weather intrusion, water, moisture, or other cause of damage resulting from construction.

1.08 CLEANUP

A. Construction debris, waste materials, packaging material, and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the fenced area described above or at the supplemental storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

1.09 RESTORATION OF STORAGE AREA

A. Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, the fence shall be removed and will become the property of the Contractor. Areas used by the Contractor for the storage of equipment or material, or other use, shall be restored to the original or better condition. Gravel used to traverse grassed areas shall be removed and the area restored to its original condition, including top soil and seeding as necessary.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

INDEX TO

SECTION 01 56 39

TEMPORARY TREE AND PLANT PROTECTION

SECTION 01 56 39

TEMPORARY TREE AND PLANT PROTECTION

PART 1 – GENERAL

1.01 QUALITY ASSURANCE

A. Contractor shall provide at least one person who shall be present at all times during planting and pruning. Individual shall be thoroughly familiar with types of plants and trees involved and shall be responsible for directing the digging, cutting, planting, and maintenance of designated plant and tree materials.

B. Qualifications: Repair of tree damage shall be completed or supervised by a tree surgeon who is a member of the National Arborist Association.

C. Pre–Work Conference – Review on site with the Owner.

D. **Trees to be removed will be marked with green flagging. Trees to remain will be marked with red flagging. Trees designated as "SPECIMEN" will be marked with yellow flagging.**

PART 2 – PRODUCTS

2.01 MATERIALS

A. Provide tree protection materials, as detailed on the construction drawings.

PART 3 – EXECUTION

3.01 PROTECTION OF SPECIMEN TREES

A. Any irreparable damage to roots, trunk or bark, or any unauthorized cutting or pruning of limbs to trees designated by the Owner as "specimen" will result in a fine. This fine shall be levied through the Application for Payment as retainage and shall be used to supplement "specimen" with tree of similar value and to perform extensive "state of the art" tree surgery in an attempt to save the tree.

3.02 METHODS OF PROTECTION

A. Use the following method to protect specimen trees. Actual determination of extent and combination of methods shall be determined on site.

B. Temporary Fence Enclosures: Construct protective fencing where indicated on the construction drawings. Protective fencing shall be installed a minimum of three feet beyond the dripline. No grading, trenching, pruning, or storage of materials shall be allowed inside this area.

3.03 REPAIR OF TREES INJURED DURING CONSTRUCTION

A. Contractor shall:

1. Repair damaged trees promptly to prevent progressive deterioration caused by damage.

2. Repair to trees damaged during construction according to standard arborcultural techniques recognized by International Society of Arborculture.

3. Remove trees damaged beyond satisfactory repair as determined by Owner. Refer to FINES AND MITIGATION in this section for loss of specimen trees.

4. Temporarily cover roots exposed during construction with wet burlap to prevent roots from drying out. Cover roots with earth as soon as possible.

5. Roots Cut During Construction: Coat roots 1 1/2 inches diameter or larger with antiseptic paint.

3.04 FINES

A. Fine values for designated **"SPECIMEN"** vegetation shall be determined by the following:

Caliper	Fine
1 inch – 2 inches	$ 150.00
2 inches – 3 inches	$ 200.00
3 inches – 4 inches	$ 250.00
4 inches – 5 inches	$ 400.00
5 inches – 6 inches	$ 500.00
6 inches – 7 inches	$ 600.00
7 inches – 8 inches	$ 750.00
8 inches – 11 inches	$ 1,500.00
12 inches – 20 inches	$ 2,000.00
21 inches & larger	$ 2,500.00

3.05 MITIGATION

A. Mitigation shall be in the form of tree transplantation. Plant materials shall be from off–site (for smaller sites) or from remote areas on site. Trees shall be comparable in size, form, and species to lost "specimen" tree. Tree species, size, and planting locations shall be approved by the Owner.

END OF SECTION

INDEX TO

SECTION 01 65 00

SHIPMENT, PROTECTION, AND STORAGE

SECTION 01 65 00

SHIPMENT, PROTECTION, AND STORAGE

PART 1 – GENERAL

1.01 GENERAL

A. Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Owner and Engineer. Additional delivery, handling, and storage requirements, specific to an individual product, may be provided in the appropriate Specification sections.

1.02 TRANSPORATION AND DELIVERY

A. Transport and handle items in accordance with manufacturer's printed instructions.

B. Schedule delivery to reduce long term on-site storage prior to installation and operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.

C. Ship equipment, materialS, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

D. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

E. Deliver spare parts at time as pertaining equipment. Deliver spare parts to owner after completion of work.

F. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.

G. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, packing, protecting and installing.

H. Assume responsibility for equipment material and spare parts just before unloading from carrier at site.

I. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.

J. Provide equipment and personnel to unload all items delivered to the site.

K. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e. Owner, other Contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems

L. Pay all demurrage charges if failed to promptly unload items.

PART 2 – PRODUCTS

2.01 PIPE

A. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings, or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

PART 3 – EXECUTION

3.01 EQUIPMENT

A. PACKAGE AND MARKING:

1. All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

2. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

B. IDENTIFICATION:

1. Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

C. SHIPPING:

1. Bearing housings, vents, and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

2. Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the Work. The Contractor shall bear the costs arising out of dismantling, inspection, repair, and reassembly.

D. DELIVERY AND HANDLING:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged, or sensitive to deterioration, theft, and other losses.

4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

E. FACTORY APPLIED COATINGS:

1. Unless otherwise specified, each item of equipment shall be shipped to the site of the Work with the manufacturer's shop applied epoxy prime coating. The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for field-applied finish coats. Electrical equipment and materials shall be painted by manufacturer.

F. UNLOADING:

1. Unloaded and handle according to manufacturer’s requirement. Contractor shall unload and store MBR manufacturer’s equipment according to their instruction.

G. STORAGE:

1. During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust, and mechanical damage and providing favorable temperature, humidity, and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

2. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least six inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

    a. Store products to allow for inspection and measurement of quantity or counting of units.

    b. Store materials in a manner that will not endanger Project structure.

c. Store products that are subject to damage by the elements, under cover in a weather-tight enclosure above ground, with ventilation adequate to prevent condensation.

d. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

e. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

f. Protect stored products from damage and liquids from freezing.

H. PROTECTION OF EQUIPMENT AFTER INSTALLATION:

1. After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo, and metal; and from the fumes, particulate matter, and splatter from welding, brazing, and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sand-blasting in those areas have been completed and accepted and the ventilation systems installed.

END OF SECTION

INDEX TO

SECTION 01 75 15

PUMP STATION – START UP

SECTION 01 75 15

PUMP STATION – START UP

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall:

1. Coordinate a schedule for start-up of various equipment and systems.

2. Notify the Engineer ten working days prior to start-up of each item or station.

3. Clean wet well of all construction debris prior to starting pumps.

4. Verify that each piece of equipment or system had been checked for proper lubrication, drive rotation, belt tension, control sequence, blockage, or other conditions which may cause damage.

5. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

6. Verify wiring and support components for equipment are complete and tested.

7. Execute start-up under supervision of responsible Manufacturer's representative, Utility representative, Engineer, and contractor's personnel in accordance with manufacturer's instructions.

8. Submit a written report that equipment or system had been properly installed and is functioning correctly.

1.02 DEMONSTRATION AND INSTRUCTION

A. In addition to the requirements of Section 1.01 above, the Contractor shall:

1. Demonstrate operation and maintenance of the system to the engineer and utility prior to final acceptance. The Contractor shall provide the equipment manufacturer's representative for a minimum of one half day of training to Utility personnel for each station. The Contractor shall coordinate and schedule demonstration of the system with the Wastewater Division and the engineer.

2. Utilize operation and maintenance manuals as basis for instruction. Review contents on manual with Utility personnel in detail to explain all aspects of operation and maintenance.

3. Demonstrate start-up, operation, control adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at equipment location.

4. Prepare and insert additional data operations and maintenance manuals when need for additional data becomes apparent during instruction.

END OF SECTION

INDEX TO

SECTION 01 77 00

CLOSEOUT PROCEDURES

SECTION 01 77 00

CLOSEOUT PROCEDURES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Closeout procedures.

B. Project record documents.

C. Warranties and bonds.

D. Operation and maintenance data.

E. Maintenance services.

1.02 RELATED SECTIONS

A. Section 01 00 01 – General Requirements.

B. Section 01 99 90 – Reference Forms.

C. Section 01 78 36 - Warranties.

D. Section 01 78 33 - Bonds.

1.03 SUBSTANTIAL COMPLETION PROCEDURES

A. In addition to the requirements in the General Conditions, contractors shall follow these procedures.

1. Contractor's List of Incomplete Items:Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

2. Submittals Prior to Substantial Completion: Complete the following a minimum of ten days prior to requesting review for determining date of Substantial Completion. List items below that are incomplete at time of request.

a. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities.

b. Submit closeout submittals including but not limited to project record documents, operation and maintenance manuals, final completion construction photographic documentation, test results, and similar final record information.

c. Submit maintenance material submittals specified in individual section, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number where applicable.

1. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.

3. Submit test, adjust, and balance records.

4. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

B. Procedures Prior to Substantial Completion: Complete the following a minimum of ten days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.

2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.

4. Perform preventive maintenance on equipment used prior to Substantial Completion.

5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in individual equipment specifications.

6. Advise Owner of changeover in electric and other utilities.

7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

9. Remove labels that are not permanent labels.

10. Complete final cleaning requirements, including touch up painting.

11. Touch up and otherwise repair and restore marred exposed finished to eliminate visual defects.

1.04 CLOSEOUT PROCEDURES

A. Submit written verification that the Contract Documents had been reviewed, Work has been observed at appropriate times, and the Work is complete in accordance with Contract Documents and ready for Engineer's review. Request in writing that the Engineer review the work. Then address all punch lists or discrepancy items developed from Engineer, Owner, and State's review.

B. Submit a draft to Engineer of all closeout documents for review at least 15 days prior to substantial completion.

C. Submit project record documents (see item 1.05).

D. Provide closeout submittals to Engineer (see item 1.06).

E. Provide any other submittals to Engineer required by governing or other authorities.

F. Provide Final Adjustment of Accounts (see item 1.07).

G. Provide maintenance services indicated in specification sections for one year from the date of substantial completion.

H. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

I. Site and building shall be cleaned per specifications.

1.05 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:

1. Drawings.

2. Specifications.

3. Addenda.

4. Change Orders and other modifications to the Contract.

5. Reviewed Shop Drawings, Product Data, and Samples.

6. Manufacturer's instructions for assembly, installation, maintenance, and adjustments.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Equipment Specifications: Legibly mark and record at each product section description of actual products installed, including the following:

1. Manufacturer's name and product model and number.

2. Product substitutions or alternates utilized.

3. Changes made by Addenda and modifications.

F. Project Record Drawings: Legibly mark each item to record actual construction including:

1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.

3. Where proposed and existing utilities cross, the Contractor shall measure and record the horizontal location and vertical separation between each crossing. Separation shall be measured between exteriors and pipes.

4. Field changes of dimension and detail.

5. Details not on original Contract drawings.

6. An as built of the construction with spot elevations and finished contours of the detention pond and all storm pipes/inlets.

7. An as-built of the sanitary sewer, water and storm drainage systems.

8. Record drawings for building, conduits, structures, and electrical, power, communications and related.

9. Piling data locations, tip and cut-off elevations and driving records.

10. Building MEP and other building features (with changes).

G. Record drawing shall be prepared according to these conditions: The Contractor shall keep accurate, legible records of the locations, types, and sizes of sanitary lines, service laterals, manholes, cleanouts, water lines, fittings, valves, hydrants, drainage pipes, drainage structures, and other related work performed under this project. Where proposed and existing utilities cross, the Contractor shall measure and record the horizontal location and vertical separation between each crossing. Separation shall be measured between exteriors of pipes. On a set of project prints provided by the Owner, the Contractor shall prepare a set of "record" drawings from the data stated above. The horizontal locations of all portions of items installed on this project shall be accurately tied down to features that are physical and visible, such as property corner markers and permanent type structures. Invert elevations of all manholes, storm sewers and structures, sanitary sewers, and lift stations shall be clearly indicated. These

"record" drawings shall be kept clean and dry and maintained in a current state with the progress of the work. If at any time, a copy of this plan or portion of it is requested by the Owner, such copy shall be made available within 24 hours after the request is made.

Before final acceptance of the completed installation and final payment by the Owner, the Contractor shall deliver to the Engineer, three sets of "Record" Drawings accurately depicting the horizontal and vertical as–built data described in the above paragraph. "Record" drawings for the items installed on this project shall be certified by a licensed surveyor, other than Thomas & Hutton, registered in South Carolina. The size of the drawings shall be 24" x 36". The "Record" drawings shall have a coordinate system based on the South Carolina State Plane Coordinate System, East Zone, North American Datum of 1983 (NAD83). Elevations shall be based on the North American Vertical Datum of 1929 (NGVD 29). All measurements and coordinates shown shall use the U.S. Survey flood definition. Coordinates shall be shown on all drainage storm manholes/boxes and all other related work performed under this contract, including an as built condition of the detention pond with spot elevations and finished 1-foot contours. Vertical data including but not limited to, structure and manhole frame and inverts, pipe inverts, control levels, bottom, site grading, and as-built grading shall be shown. In addition to the "Record" drawings, Contractor shall deliver to Engineer electronic AutoCAD (v. 14 or later) files of all the data described above on a CD-ROM.

H. Deliver final project record drawing files to Engineer in an electronic AutoCAD (v.14 or later) and three paper sets. Find project record drawing shall include Engineer comments and shall conform to regulatory agency requirements.

I. Submit final documents to Engineer at least 15 days prior to claim for final Application for Payment.

1.06 CONTRACTOR'S CLOSEOUT SUBMITTAL TO ENGINEER

A. Closure of the construction contract, including final payment to the Contractor, requires the following:

1. Contractor's submission to the Engineer of the following:

a. Project record drawings.

b. An affidavit, in the form of the AIA G706, that wages, bills for materials and equipment, and other indebtedness connected with the work have been paid (Contractor's affidavit of payment & debt and claims);

c. A certificate in the form of AIA G715 (Accord for Certificate of Insurance) issued by an authorized representative of the Contractor's insurance company certifying completed project insurance coverage as required by the contract documents;

d. A statement that the Contractor knows of no reason that the completed project insurance will not be renewable to cover the period required by the Contract Documents;

e. Consent of surety, if any, to final payment, in the form of AIA G707 (Consent of Surety to Final Payment);

f. Other information required by the Owner establishing the Contractor's payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims and security interests arising out of the contract, all in the forms as designated by the Owner;

g. Inspection reports that may not be a part of the record documents;

h. All warranties and quantities;

i. O&M Manuals;

j. Training Manuals;

k. Final Adjustment of Accounts; and

l. A list of all claims against Owner that the Contractor believes is unsettled.

m. Other documents required by the Owner and State guidelines and requirements,

1.07 FINAL ADJUSTMENT OF ACCOUNT

A. Submit a final statement of accounting to the Engineer.

B. Statement shall reflect all adjustments to the contract sum:

1. The original contract sum.

2. Additions and deductions resulting from:

a. Previous change orders;

b. Unit prices;

c. Penalties and bonuses;

d. Deductions for liquidated damage; and

e. Other adjustments.

3. Total contract sum, as adjusted.

4. Previous payments.

5. Remaining sum due.

1.08 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit as directed in Section 01 78 23 Operating and Maintenance Information.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Provide spare parts, maintenance, and extra Products in quantities specified in individual specification sections.

B. Deliver to location as directed; obtain receipt prior to final payment.

C. Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers.

D. Stencil contents on containers

1.11 WARRANTIES AND BONDS

A. Provide duplicate notarized copies and a PDF of each.

B. Execute and assemble transferable warranty documents from Subcontractors, suppliers, and manufacturers.

C. Provide Table of Contents and assemble in three D side ring binder with durable plastic cover.

D. Submit prior to final Application for Payment.

E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.12 MAINTENANCE SERVICE

A. Furnish service and maintenance of components indicated in specification sections for one year from date of Substantial Completion.

1. Manufacturer or Supplier name.

2. Unit name, specific part name.

3. Manufacturers catalogue number or other identifying information.

4. Precautionary information.

B. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.

D. Maintenance service shall not be assigned or transferred to any agent or Subcontractor without prior written consent of the Owner.

1.13 FINAL CLEANING

A. Execute final cleanup prior to final project acceptance.

B. Remove waste and surplus materials, rubbish, and construction facilities from the site.

C. Clean all exterior paved surfaces, establish vegetation or ground cover on all disturbed areas.

D. Clean all sight-exposed interior and exterior surfaces and work areas.

E. Clean debris and sediment from all new storm pipes and structures.

F. Repair all cracked or damaged curbs, sidewalks and concrete areas. If the crack is irregular or goes through the full depth of the concrete, remove the damaged section and replace.

G. Removal all soil and other debris from the new storm system, curb, and paved areas.

H. Comply with requirements of Section 01 77 01.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION

INDEX TO

SECTION 01 77 01

CLEANING

SECTION 01 77 01

CLEANING

PART 1 – GENERAL

1.01 RELATED SECTIONS

A. Documents affecting the work of this Section include, but are not necessarily limited to, the General Conditions, the Supplementary Conditions, and other Sections in Division 1 of these Specifications.

B. In addition to standard described in this Section, comply with requirements for cleaning as described in pertinent other Sections of these Specifications.

1.02 DESCRIPTION OF WORK INCLUDED

A. Throughout the construction period, maintain the buildings and site in a standard of cleanliness as described in this Section.

B. Execute cleaning during progress of the work and at completion of the work.

1.03 QUALITY ASSURANCE

A. Conduct daily inspection, and more often if necessary, to verify that requirements for cleanliness are being met.

B. In addition to the standards described in this Section, comply with pertinent requirements of governmental agencies having jurisdiction.

C. Conduct cleaning and disposal operations to comply with all Federal, State, and local codes, ordinances, regulations, and anti-pollution laws.

PART 2 – PRODUCTS

2.01 CLEANING MATERIALS AND EQUIPMENT

A. Provide required personnel, equipment, and materials needed to maintain the specified standard of cleanliness.

B. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

C. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

D. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

2.02 COMPATIBILITY

A. Use only the cleaning materials and equipment which are compatible with the surface being cleaned, as recommended by the manufacturer of the material.

PART 3 – EXECUTION

3.01 PROGRESS CLEANING

A. General

1. Retain stored items in an orderly arrangement allowing maximum access, not impeding traffic or drainage, and providing protection of materials.

2. Do not allow accumulation of scrap, debris, waste material, and other items not required for construction of the work.

3. At least twice each month, and more often if necessary, completely remove all scrap, debris, and waste material from the job site.

4. Provide adequate storage for all items awaiting removal from the job site, observing requirements for fire protection and protection of the environment.

5. Execute periodic cleaning to keep the work, the site and adjacent properties free from accumulation of waste materials, rubbish, and wind-blow debris, resulting from construction operations.

B. Site

1. Daily, and more often if necessary, inspect the site and pick up all scrap, debris, and waste material. Remove such items to the place designated for their storage.

2. Weekly, and more often it necessary, inspect all arrangements of materials stored on the site. Restack, tidy, or otherwise service arrangements to meet the requirements of paragraph 3.01, part A, Section 1.

3. Maintain the site in a neat and orderly condition at all times.

4. Provide onsite containers for the collection of waste materials, debris and rubbish. Empty as necessary to prevent overflow and nuisance odor.

C. Structures

1. Weekly, and more often if necessary, inspect the structures and pick up all scrap, debris, and waste material. Remove such items to the place designated for their storage.

2. Weekly, and more often if necessary, sweep interior spaces clean ("Clean", for the purpose of this subparagraph shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and a hand-held broom).

3. As required preparatory to installation of succeeding materials, clean the structures of pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using equipment and materials required to achieve the necessary cleanliness.

4. Following the installation of finish floor materials, clean the finish floor daily (and more often if necessary) at all times while work is being performed in the space in which materials are installed *("Clean", for the purpose of this paragraph, shall be interpreted as meaning free from foreign material which, in the opinion of the Architect orEngineer, may be injurious to the finish floor material).*

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

C. Control dust on the site through the use of watering trucks and other accepted means.

3.03 FINAL CLEANING

A. Execute final cleanup prior to final project acceptance.

B. "Clean", for the purpose of this Article, and except as may be specifically provided otherwise, shall be interpreted as meaning the level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.

C. Prior to completion of the work, remove from the job site all tools, surplus materials, equipment, scrap, debris, and waste. Conduct final progress cleaning as described in Article 3.01.

D. Site

1. Clean project site, yard and grounds disturbed by construction activities. Unless otherwise specifically directed by the Architect or Engineer, broom clean paved areas on the site and public paved areas adjacent to the site and rake clean other surfaces of the grounds. Remove stains, spills, and other foreign deposits.

2. Completely remove resultant debris.

E. Structures

1. Exterior

a. Visually inspect exterior surfaces and remove all traces of soil, waste materials, smudges, and other foreign matter.

b. Remove all traces of splashed materials from adjacent surfaces.

c. If necessary to achieve a uniform degree of cleanliness, hose down the exterior of the structure.

d. In the event of stubborn stains not removable with water, the Architect or Engineer may require light sandblasting or other cleaning at no additional cost to the Owner.

2. Interior

a. Visually inspect interior surfaces and remove all traces of soil, waste materials, smudges and other foreign matter.

b. Remove all traces of splashed material from adjacent surfaces.

c. Remove paint droppings, spots, stains and dirt from finished surfaces.

3. Glass

a. Clean inside and outside

4. Polished surfaces

a. To surfaces requiring routine application of buffed polish, apply the polish recommended by the manufacturer of the material being polished.

5. Replace disposable air filters.

6. Clean ducts, blowers, coil units and HVAC.

F. Remove waste and surplus materials, rubbish, and construction facilities from the site.

G. Clean all exterior paved surfaces, establish vegetation or ground cover on all disturbed areas.

H. Clean all sight-exposed interior and exterior surfaces and work areas.

I. Clean debris and sediment from all new storm pipes and structures.

J. Repair all cracked or damaged curbs. If the crack is irregular or goes thru the full depth of the curb, remove the damaged section and replace.

K. Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

L. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations immediately prior to Occupancy for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

c. Rake grounds that are neither planted nor paved smooth, even-textured surface.

d. Remove tools, construction equipment, machinery, and surplus material from Project site.

e. Clean exposed exterior and interior finishes to a dirt-free condition, free of grease, dust, stains, films, fingerprints, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

g. Sweep concrete floors broom clean in unoccupied spaces.

h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.

i. Power scrub and power buff resilient flooring surfaces, tile, and fluid-applied flooring.

j. Clean transparent materials, including mirrors and glass in doors windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

k. Remove labels that are not permanent.

l. Wipe surfaces of mechanical and electrical equipment, elevator equipment where applicable, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection. Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.

p. Clean lighting fixtures, lamps, globes, and reflectors to functions with full efficiency.

q. Leave Project clean and ready for occupancy.

M. Schedule final cleaning as approved by the Architect or Engineer to enable the Owner to accept a completely clean work.

N. Prior to final completion or Owner occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas to verify that the entire work is clean.

3.04 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion and final cleaning.

B. Repair of remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repair or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.

a. Do not paint over “UL” and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

3.05 CLEANING DURING OWNER’S OCCUPANCY

A. Should the Owner occupy the work or any portion thereof prior to its completion by the Contractor and acceptance by the Owner, responsibilities for interim and final cleaning shall be as determined by the Architect or Engineer in accordance with the General Conditions of the Contract.

END OF SECTION

INDEX TO

SECTION 01 78 23

OPERATION AND MAINTENANCE INFORMATION

SECTION 01 78 23

OPERATING AND MAINTENANCE INFORMATION

PART 1 – GENERAL

1.01 SCOPE

A. Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

B. O&M instructions must be submitted and accepted before on-site training may start.

PART 2 – INFORMATION

2.01 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data specifically application to this contract and a complete and concise depiction of the provided equipment, product, or system. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section. Provide hard and digital copies.

A. Package Quality

1. Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

B. Package Content

1. Data package content shall be as shown in the paragraph titled “Schedule of Operation and Maintenance Data Packages.” Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission.

C. Changes to Submittals

1. Manufacturer-originated changes or revisions to submitted data shall be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Engineer for final acceptance of submitted data, shall be submitted by the Contractor within ten calendar days of the notification of this change requirement.

2.02 TYPES OF INFORMATION REQUIRED

A. GENERAL:

1. O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. OPERATING INSTRUCTIONS:

1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:

a. SAFETY PRECAUTIONS: List personnel hazards for equipment and list safety precautions for all operating conditions.

b. OPERATOR PRESTART: Provide requirements to set up and prepare each system for use.

c. START-UP, SHUTDOWN, AND POST SHUTDOWN PROCEDURES: Provide a control sequence for each of these operations.

d. NORMAL OPERATIONS: Provide control diagrams with data to explain operation and control of systems and specific equipment.

e. EMERGENCY OPERATIONS: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.

f. OPERATOR SERVICE REQUIREMENTS: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

g. ENVIRONMENTAL CONDITIONS: Provide a list of environtmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. PREVENTIVE MAINTENANCE:

1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

a. LUBRICATION DATA: Provide lubrication data, other than instructions for lubrication, in accordance with paragraph 2.0-B6.

1. A table showing recommended lubricants for specific temperature ranges and applications;

2. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and

3. A lubrication schedule showing service interval frequency.

2. PREVENTIVE MAINTENANCE PLAN AND SCHEDULE: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. CORRECTIVE MAINTENANCE:

Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.

1. TROUBLESHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

2. WIRING DIAGRAMS AND CONTROL DIAGRAMS: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.

3. MAINTENANCE AND REPAIR PROCEDURES: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.

4. REMOVAL AND REPLACEMENT INSTRUCTIONS: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.

5. SPARE PARTS AND SUPPLY LISTS: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for

facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.

6. CORRECTIVE MAINTENANCE MANHOURS: Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. APPENDICES:

1. The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

a. PARTS IDENTIFICATION: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

b. WARRANTY INFORMATION: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

c. PERSONNEL TRAINING REQUIREMENTS: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

d. TESTING EQUIPMENT AND SPECIAL TOOL INFORMATION: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

e. CONTRACTOR INFORMATION: Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name, address, and telephone number of the manufacturer’s representative and service organization most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

PART 3 – EXECUTION

3.01 TRANSMITTAL PROCEDURE

A. Unless otherwise specified, O&M manuals, information, and data shall be submitted as follows:

1. Submit one draft copy of completed volumes 30 days prior to final walk through. This copy will be reviewed and returned after final inspection, with Engineer comments. Only complete sets of O&M instructions will be reviewed for acceptance. Revise content of all document sets as required prior to final submission.

2. Submit five (confirm with Owner and Engineer final number required prior to submittal) hard copies of revised final volumes and one electronic PDF copy within ten days of conducting the final walk through.

3. Hard copies shall be submitted in commercial quality, durable, D-ring binders.

B. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.

C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

END OF SECTION

INDEX TO

SECTION 01 78 25

PLANT TESTING, STARTUP, AND COMMISSIONING

SECTION 01 78 25

PLANT TESTING, STARTUP, AND COMMISSIONING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Provide planning, functional completion testing, startup and commissioning as indicated and specifies. Section includes:

1. Plant Checkout Plan.

2. Functional Completion Testing.

3. Startup.

4. Commissioning.

5. Performance Testing.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. B31.1: Power Piping Code.

B. American Water Works Association (AWWA):

1. C600: Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.03 DEFINITIONS

A. The Plant Checkout Plan (the Plan) incorporates all aspects of functional completion testing, startup, commissioning, performance testing, training, and reliability tests to ensure the facility operates properly and meets deign intent and performance.

B. Functional Completion Testing is testing of the equipment and unit process systems to confirm that construction and installation has been completed in anticipation of initial startup of the equipment and unit process systems. Functional Completion Testing includes:

1. Physical Checkout shall be defined as the process of physically inspecting products after they have been installed in the Work to determine if the Products have been properly and completely installed, and are ready for startup.

2. Functional Completion Testing shall be defined as testing that is performed by the Contractor, with Supplier or Manufacturer assistance, on Products

after they have been installed in the Work, and after the performance of physical checkout, for the purpose of proving that the tested Products meet the requirements of the pertinent technical specifications. Administrative, test criteria, and minimum technical requirements for field testing are specified in Paragraph 1.08 of this Section.

C. Startup (clean water) shall be defined as the operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate the operation of the equipment or unit process systems with other equipment that is a part of, or a treatment process for the Facility. Administrative and minimum technical requirements for startup are specified in Paragraph 1.09 if this Section (24 hours minimum, generally three to four days).

D. Commissioning shall be defined as the operation of equipment of unit process systems using wastewater, process liquids or process solids, plant support equipment, and plant utilities to demonstrate equipment or unit process systems are capable of processing water or wastewater at specified flows and conditions for a sustained period of operation as required by this section or equipment or unit process systems are ready to begin Performance Testing. Administrative and minimum technical requirements for Commissioning are specified in Paragraph 1.10 of this Section (fourteen days minimum).

E. Performance Testing is defined as a test to demonstrate the specified throughout of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees (seven days).

F. The Testing and Startup Coordinator shall be defined as the person provided by the Contractor to coordinate and oversee the total spectrum of testing and inspection activities required by the Contract Documents. The Testing and Startup Coordinator shall have been in responsible charge of at least two similar Projects in the last four years.

G. Startup coordinator shall be the primary contact to execute the Plant check out plan.

1.04 ROLES AND RESPONSIBILITES

A. The Contractor shall provide all outside services, materials, labor, supplies, test equipment and other items necessary to perform the Testing, Startup and Commissioning specified herein. In addition, the Contractor shall arrange for and provide the participation or assistance of survey crews, quality control technicians, Supplier's representative(s), and required governmental agency representatives, as necessary.

B. The Contractor shall provide the services of the Supplier's or Manufacturer's representative(s) as follows:

1. Assistance during installation and field testing as specified in PART 3 of the specifications.

2. Startup.

3. Commissioning.

C. The Supplier's representative's activities required by this Section are in addition to the requirements for vendor training and other services specified elsewhere in the Contract Documents. Timing for the performance of these services is to be defined in the Contractors Plant Checkout Plan.

D. The Engineer will review and comment on the Contractor's deliverables, observe the physical activities, the shop and field testing, witness functional testing, and maintain the permanent record of all testing results, and provide verification of conformance to the specifications. The Engineer's right to review work, witness tests or monitor or assess the Work and activities does not relieve the Contractor of its obligation to comply with the requirements of the Contract Documents nor does it imply completion of the Work.

1.05 SUBMITTALS

A. Submit the following shop drawings.

1. Submit a Plant Checkout Plan for the facility, with a listing of tests, activities, and an associated timeline.

B. Qualification Data:

1. Submit resumes for each team member proposed for testing, startup, and commissioning.

a. Include a minimum of three startup and commissioning references including: project name, project location, contact person's name, contact person's telephone number, contact persons role during the project, dates of startup, and commissioning.

1.06 QUALITY ASSURANCE

A. Preparation of the plant checkout plan, functional completion testing, and startup and commissioning shall be performed by personnel:

1. Trained and experienced in O&M of the described equipment.

2. Familiar with the treatment or unit process.

1.07 PLANT CHECKOUT PLAN

A. The Contractor shall be responsible for preparing, coordinating, and executing the Plan.

1. The Contractor shall use the resources of the equipment and unit process systems suppliers in this work, particularly for specific equipment and unit process systems.

2. An initial draft of the Plan shall be submitted as indicated here:

    a. The initial draft of the Plant Checkout Plan shall be completed and submitted by the Contractor to the Engineer for review. The Engineer will require at least 15 days to review the submittal and return with any comments.

    b. The Contractor shall incorporate the Engineer's comments into the revised Plan within 15 days of the receiving comments, and reissue the Plan to the Engineer and Owner.

    c. The Contractor shall regularly schedule meetings with the Engineer and Owner to review and coordinate activities required by the Plan.

B. The Contractor shall provide a dedicated field staff to support the Plan activities. A Startup Coordinator shall be responsible for day to day activities and shall be the primary contact with the Engineer regarding Plan activities. Support staff shall include but not limited to designated mechanical, electrical and instrumentation and control engineers and technicians, and operating staff.

1. The Contractor may require assistance from the Owner's operating and maintenance staff in commissioning and performance testing activities specified herein.

    a. The Contractor may require use of Owner's operating maintenance staff in performance testing activities, at the convenience of the Owner.

    b. These activities shall be incorporated in the Plan in defining responsibilities of the Plan participants.

C. The Plant Checkout Plan shall define:

1. The logical and systematic performance of physical inspections, field and functional test, startup, commissioning, and performance testing including:

    a. A chronological schedule of all testing and inspection activities.

    b. A checklist of all inspection and testing activities broken down by location, discipline, system, and device or item.

    c. All blank forms proposed by the Contractor for verification or recording of the functional completion testing, startup, commissioning and performance testing.

    d. An index which cross references the forms to their intended application(s).

    e. A list of all suppliers' certifications, including those required by the applicable technical specifications. Provisions shall also be included for retesting, in the event it is required.

2. A list of participants in functional completion testing, startup, commissioning, and subsequent performance testing.

3. A list of special test equipment required for functional testing, startup, commissioning, and performance testing.

4. Sources of the test media (wastewater, water, power, air, etc.) for functional completion testing.

5. The proposed method of delivery of the media to the equipment to be tested during functional completion testing, startup, commissioning, and performance testing.

6. Temporary or interim connections for the sequencing of multiple units during functional completion testing, startup, commissioning, and performance testing.

7. Ultimate disposal of the test media after functional completion testing, startup, commissioning, and performance testing.

D. The Plant checkout plan shall be reviewed by the Engineer and Owner, modified or revised as necessary by the Contractor, then re-reviewed by the Engineer. The Contractor shall continue to update the Plan, working in conjunction with the Engineer and Owner, prior to the start of the scheduled equipment checkout. Each specific element of the plan must receive review or comment by the Owner, two weeks prior to the actual commencement of testing as defined herein.

E. The Contactor shall designate, in the Plan, a Startup Coordinator, to coordinate and manage the activities defined in the Plan.

1.08 FUNCTIONAL COMPLETION TESTING

A. Functional Completion Testing shall be completed as construction and installation of equipment is completed to demonstrate that the equipment is ready for equipment and unit process systems startup.

1. Functional Completion Testing shall be done in coordinated manner based on the Plant Checkout Plan prepared by the Contractor.

   a. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

   b. Additional witnesses, such as the Engineer, may be present to represent the Owner.

2. Functional Completion Testing procedures and documentation forms shall be developed by the Contractor. The procedures shall include a listing of items inspected for Functional Completion Testing.

3. In any equipment or unit process systems do not meet Functional Completion Testing requirements, it shall be the responsibility of the

Contractor and equipment suppliers to make the necessary corrections or replacements and repeat the test.

4. The equipment and unit process systems shall not be started up or put into service until the Functional Completion Testing is completed as evidenced by a completed Functional Completion Testing certificate for the equipment or subsystem.

5. Modifications to the equipment and unit process systems required to Functional Completion Testing requirements shall be provided, and all retesting shall be performed at no additional cost to Owner.

6. A Functional Completion Testing Certificate or recording form shall be prepared by the Contractor for each piece of equipment or unit process and submitted to the Engineer and Owner for review.

1.09 STARTUP

A. Startup activities for the Facility shall not be initiated until the Functional Completion Testing are satisfactorily completed for the equipment or unit process systems.

B. The requirements of this section shall be satisfactorily completed prior to beginning Commissioning for the equipment and unit process systems.

C. The Contractor shall be responsible for startup.

1. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

2. Additional witnesses, such as the Engineer, may be present to represent the Owner.

D. For equipment or unit process systems that do not meet the specified Startup requirements, it shall be the responsibility of the Contractor and equipment or unit process systems suppliers to make the necessary corrections or replacements and repeat Startup at no additional cost to the Owner.

E. Startup Reports for each piece of equipment or unit process shall be completed and submitted by the Contractor to the Engineer and Owner.

F. The Contractor shall not begin Commissioning until Startup certificate is completed and is submitted.

1.10 COMMISSIONING

A. Commissioning activities for the Facility shall not be initiated until the requirements of Startup are completed for the equipment or unit process systems.

B. The requirements of this section shall be satisfactorily completed prior to beginning Performance Testing for equipment and unit process systems.

C. Commissioning shall be used by the Contractor and equipment or unit process suppliers to adjust, fine tune, modify, and prepare the equipment or system for continuous operation and Performance Testing.

1. Equipment shall not be operated without the guidance of qualified personnel having the knowledge and experience necessary to conduct proper operation thereof and obtain valid results.

2. All required adjustments, test, operation checks, and Startup and Commissioning activities shall be provided by qualified personnel.

3. Contractor shall be responsible for planning, supervising, and executing the Startup and Commissioning of the equipment and unit process systems with the assistance of equipment or unit process systems suppliers in accordance with the Plan.

D. The Contractor shall be responsible for Commissioning under the direction of its Startup Coordinator.

1. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

2. Additional witnesses, such as the Engineer, may be present to represent the Owner.

E. For equipment or unit process systems that do not meet Commissioning requirements, it shall be the responsibility of the Contractor and equipment or unit process systems suppliers to make the necessary corrections or replacements and repeat Commissioning at no additional cost to the Owner.

F. The equipment or unit process systems shall not be Performance Tested or otherwise placed into service until Commissioning is completed as evidenced by a completed Commissioning certificate for the equipment or unit process systems.

G. Commissioning Certificates for each piece of equipment or unit process shall be completed and submitted by the Contractor to the Engineer and Owner.

1.11 PERFORMANCE TESTING

A. Performance Testing is defined as a test to demonstrate the specified throughout of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum complicate with the equipment or unit process systems performance requirements and guarantees (Seven days).

B. During the performance testing, daily equal volume composite samples from the influent and effluent shall be obtained by the Contractor (or Owner if contractor makes prior arrangements for the owner to assist).

C. These samples will be for the measurement of the following parameters by the contractor:
1. BOD.

2. TSS.
3. TKN.
4. NH3.
5. TP.
6. TN.
7. Flow.

D. The treated effluent shall meet these parameters:

Parameter	Effluent Limits
BOD	<5 mg/L
TSS	<5 mg/L
TKN	<13 mg/L
NH3	<2 mg/L
TP	<9mg/L
TN	<20 mg/L

1.12 OPERATING PERIOD

A. Operating period is defined as a 30 day period that the Owner operates the plant while the contractor provides personnel which are available to answer questions, address operational issues and equipment malfunctions and adjustments, and similar items during the initial operating period.

PART 2 – PRODUCTS

Not used

PART 3 – FDA EXECUTION

3.01 PLANT CHECKOUT PLAN

A. The Plan shall include the following items as a minimum:

1. Cover Sheet with Plant identification, title, date, and other information as needed to properly identify the specific information for the Facility.

2. Status and revisions sheet with appropriate dates and signatures spaces to document the development and status of the document.
3. Table of Contents including Appendix.

4. Equipment and systems descriptions with anticipated break down for individual startup activities. This section shall define the individual "packages" for startup activities for the equipment or unit process systems.

5. Schedule of events and other activities covered by the Plan.

   a. The schedule shall define dates for completing activities for equipment and unit process systems.

b. The schedule shall be the Contactor's best estimate of time sequence at the time of issuance.

c. The Contractor shall submit schedule updates to the Plan as necessary and at least monthly.

d. The schedule shall follow the required sequencing as specified herein.

6. Sign-off sheets consisting of certification forms or completion reports required by the specifications shall be included in the Plan. Standard forms shall be developed by the Contractor for this purpose.

7. Reports, test results and other supporting data shall be collected by the Contractor for documentation of the specific details leading to the certification or completion.

B. Following shall be the sequence for completing functional completion testing, startup, commissioning, and performance testing activities required by the Plan.

1. Bongo Influent Screen.

2. MBR Process.

3. Odor Control Unit.

4. Chlorine Contact/Disinfector.

5. Sludge Dewatering.

6. Standby generator.

7. Effluent Pump Station and LAS System.

C. Any variation in the startup sequence deemed necessary by the Contractor shall be reviewed by the Engineer prior to changing the sequence.

3.02 FUNCTIONAL COMPLETION TESTING

A. Provide 15 working days written notice to the Engineer for each Functional Completion Test so that the Engineer my witness the functional completion tests. The Engineer may witness the performance of any or all Functional Completion Testing, at their option.

B. Testing shall be conducted in accordance with the accepted Plan using applicable standard techniques reviewed by the Engineer and Owner.

1. Local and remote instrumentation may be used to record test data where it is determined the devices have been calibrated and sufficient to obtain necessary data.

C. The Contractor shall develop standard data sheets to document Functional Completion Testing requirements have been met for all equipment and unit process systems included in the Plan.

1. As equipment testing is completed the appropriate data sheet shall be completed and signed by the responsible party and submitted to the Engineer for review and acceptance.

2. Data values shall be stated in the engineering units noted in the equipment specifications.

D. A detailed Functional Completion Test plan shall be prepared and submitted to the Engineer for review and comment as noted paragraph 1.08 above.

1. The plan shall be prepared by the Contractor in conjunction with the equipment or subsystem supplier and shall become a part of the overall Plan.

E. In the event no reference to procedures is made, or no procedures for startup and commissioning are contained in a technical specification for the following test parameters, the following shall be the checkout requirements. Should there requirements conflict with the Supplier's recommendations or in any way be less stringent that the Supplier's requirements, they shall be superseded by the Supplier's requirements for checkout testing.

1. Measurement of wearing ring clearances for all pumps requiring assembly, so equipped:

a. Take two readings taken opposed to each other by 90 degrees.

b. All measured clearances shall be within Supplier's specifications for new installation. Replace and recheck rings found to be out of round or out of specified tolerance.

2. Measure of Impeller Bore for all pumps requiring assembly:

a. Take two readings opposed to each other by 90 degrees.

b. All measured clearances shall be within Supplier's specifications for new installation. Replace and recheck impellers found to be out of round or out of specified tolerance.

3. Measurement of shaft runout for all rotating equipment requiring assembly:

a. Remove bearings from the shaft. Support shaft on pedestal rollers or in a lathe.

b. Check each shoulder on the shaft.

c. Take two readings for each shoulder, opposed to each other by 90 degrees.

d. All measured clearances shall be within Supplier's specifications for new installations. Replace and recheck shafts found to be out of round or out of specified tolerance.

4. Vibration Measurements:

a. Provide vibrational signature testing and documentation for each piece of direct drive or close coupled rotating equipment with a motor HP of 100 or above and a rated operating speed in excess of 1999 RPM.

b. Unless specified otherwise, the current edition of the Hydraulic Institute Standard, "Acceptable Field Vibration Limits" shall be the standard for vibrational testing.

c. Take all specified vibrational readings in three directions: vertical, horizontal, and axial.

d. Provide vibrational measurements in the following engineering units:

1. Displacement in thousandths of an inch (mils), peak to peak.

2. Velocity in inches per second (ips), peak to peak.

3. Acceleration in feet per second per second (lg=32.3 ft. /sec. /sec.) zero to peak.

4. Spike energy in g-SE.

5. The vibrational readings shall be less than the device rotating frequency, and within the operating band specified by the Supplier.

6. Amplitude Allowable Maximums:

RPM	Amplitude inches peak to peak:
3,000 and above	0.001
1,500 – 2,999	0.002
1,000 – 1,499	0.0025
999 and below	0.003

5. Belt Drivers:

   a. All belts shall ride within the sheave and not slip to the groove(s).

   b. Belt tension shall be in accordance with Supplier's recommendations.

   c. Pulley alignment shall be within Supplier's recommendations.

6. Gear Drives and Reducers:

   a. Check gears for lash at no less than three points around the gear.

   b. Rotate gears a full 360 degrees while checking alignment.

7. Coupling/Shaft Alignment:

   a. Perform all final alignments and checks with a dial indicator or a laser device. Feeler gauges and straight edges are not acceptable.

   b. Eliminate soft foot conditions prior to aligning.

   c. When checking for final soft foot, any displacement in excess of 0.002" must be corrected.

   d. When checking for pipe strain, any displacement in excess of 0.002 inches requires piping realignment.

   e. Alignments will not be regarded as final until the grout is set and all piping has been attached. Demonstrate that alignment is not changes by attachment of piping.

   f. Shim the driving element, never the driven element.

   g. Take bracket sag connections into account when using a dial indicator. Bracket sag shall be determined on a rigid pipe.

   h. Mount a dial indicator to the driven element so that it can be rotated. Rotate both elements while aligning.

   i. When aligning three coupled elements, align gear reduction elements with the driven element first, then align the driver to the gear reduction element.

   j. Check all four alignments, i.e., angular alignment in the vertical and horizontal planes and parallel alignment in the vertical and horizontal planes.

   k. The acceptable alignment accuracy for flexible couplings is +0.005 inches, or the Supplier's specifications, whichever is more stringent.

   l. The dial indicators must be perpendicular to the alignment surface.

m. Number hold down nuts prior to tightening. Loosen in reverse order. Tighten in ascending order.

n. Use only clean, deburred shims. Clean the machine base and feet from rust or burrs prior to alignment.

8. Measure of Noise (dBA):

a. Eliminating noise sources generated by adjacent construction activity prior to testing.

b. Establish a background noise level prior to testing.

c. Perform noise level testing on each installed device as required by the technical specifications.

d. The maximum noise level exposure is 65 dBA over eight hours continuous for office, shop, and other areas where the Owner's personnel will be performing their duties.

e. The maximum noise level at five feet from the generator shall be 65 dBA.

9. Hydrostatic Testing:

a. AWWA C600 standards latest edition are the standards for all hydrostatic testing.

b. Visually inspect all welds prior to testing, for cracks, undercut on surface greater than 1/32-inches deep, lack of fusion on surface, reinforcement greater than Table 127.4.2 located in ANSI B31.1 Power Piping, and incomplete penetration (when accessible). Repair or rework as directed by the Engineer.

c. At no time during hydrostatic testing shall any part of the piping system be subjected to a stress greater than 90 percent of its yield strength at test temperature.

d. After ten minutes of full hydrostatic test pressures, make an examination for leakage of all joints, connections, and all regions of high stress, such as around openings and thickness transition sections.

e. Unless otherwise specified, the minimum required hydrostatic test pressure shall be one and a half times the design pressure as specified or 150 psi minimum or as indicated.

F. Where required by the equipment specifications, the Contractor shall furnish an authorized, competent representative of the equipment or unit process supplier to supervise and coordinate the Functional Completion Testing program.

1. Instrument readings and other test data shall be tabulated by the Contractor.

G. Document Requirements:

1. Certificates are required for all Functional Completion Testing for equipment and unit process systems. Four copies of the completed certificates shall be supplied for review by the Engineer. Contents of the certificated shall be supplied for review by the Engineer. Contents of the certificate shall be at a minimum:

a. Contractor Review Comments, and Approval Page. This page shall include Certification by the preparer that he or she is the person responsible for the test data and the data is authentic and accurate. This page shall include a listing and signature of all witnesses to the test.

b. Equipment Suppliers Review Comments, and Approval Page. This page shall include Certification by the equipment or unit process systems suppliers that the equipment or unit process systems are properly installed and suitable for startup.

c. Process, Equipment, and P&ID's involved in this Functional Completion Test.

d. Schedule.

e. Test Descriptions/Procedures.

1. Equipment or unit process systems tested.

2. Test dates.

3. Electrical Inspection and Tests.

4. Test results.

5. Any repairs or corrections required to obtain acceptable test results.

6. Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

7. Copies of calibration records for plant installed instrumentation.

f. Certify Mechanic and Installation. Inspection and certification to be conducted by equipment representative. Inspect and certify that each piece of equipment meets the following requirements:

1. Not damaged in transportation or installation.

2. Properly installed with no undue force imposed from piping or supports.

3. Is properly lubricated.

4. Motor rotation is correct.

5. Free of overheating.

6. Free of vibration.

7. Free of noise.

8. Functions without overloading.

9. Piping and other connections are completed.

10. No leaks at equipment connections (static pressure testing).

g. Certify Electric Calve Mechanics and Installation.

h. Inspect and certify that each valve meets the following requirements:

1. Not damaged in transportation or installation.

2. Properly installed with no undue force imposed from piping or supports.

3. Is properly lubricated.

4. Motor rotation is correct.

5. Free of overheating.

6. Free of vibration.

7. Free of noise.

8. Functions without overloading.

9. Piping and other connections are completed.

10. No leaks at equipment connections (static pressure testing).

i. Instrumentation and Control Inspection and Test.

2. Tests certificates shall be submitted no later than 30 calendar days, after testing ends. The Engineer and Owner shall have no more than 30 calendar days to complete a review and return with exceptions noted.

3.03 STARTUP

A. Provide 15 days written notice to the Engineer for each startup procedure so that the Engineer may witness the each startup procedure. The Engineer may witness the performance of any or all each startup procedure, at their option.

B. Startup shall begin at the conclusion of Functional Completion Testing, when the equipment or unit process systems are subject to full operation using a process flow substitute.

1. Startup activities shall be carried out to show the equipment and unit process systems are functional.

2. The various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Startup services for the new facility.

C. The Contractor shall coordinate all startup activities for equipment and unit process systems in accordance with the accepted Plan. The Contractor shall develop a detailed Startup plan as part of that Plan that includes the following as a minimum:

1. Description of the overall, general startup process.

2. List of equipment and unit process systems included for Startup activities.

3. Detailed startup sequence of activities.

4. Equipment and system boundaries as shown using marked-up P&IDs.

5. Listing of staff and responsibilities for activities.

D. Startup Requirements: The following are minimum requirements for completion of Startup activities:

1. Startup shall show that the equipment or unit process systems are suitable for continuous operation.

a. Startup shall also demonstrate that local and remote instrumentation and controls are functioning properly and communicating with each other properly.

b. Equipment or unit processes shall be operated for a minimum of 24 hours without interruptions in service.

c. If the startup fails, the contractor will be responsible for redoing the startup testing at no additional costs to the Owner.

E. Document Requirements

1. A Startup certificate shall be prepared and submitted to the Engineer for review and returned with any exceptions noted. The reports shall include, but not be limited to, the following:

a. Contractor Review Comments and Approval Page. This page shall include Certification by the preparer that he/she is the person responsible for the test data and the data is authentic and accurate. This page shall include a listing and signature of all witness's to the test. Certification by the Contractor that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that the equipment or unit process systems are suitable for Commissioning.

b. Equipment Suppliers Review Comments and Approval Page. This page shall include Certification by the equipment or unit process systems suppliers that the equipment or unit proves systems have been started up properly and operated within the design parameters. Certification by the equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that the equipment or unit process systems are suitable for Commissioning.

c. Engineer Review Comments, and Approval Page.

d. Process, Equipment, and P&IDs Involved in this startup test.

e. Startup Schedule.

f. Test Description and Procedures.

    1. Equipment or unit process systems tested.

    2. Test dates.

    3. Electrical Inspection and Tests.

    4. Test results.

    5. Any repairs or corrections required to obtain acceptable test results.

    6. Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

g. Appendix:

    1. A summary of all data used in the calculations, including source, and formulas with all terms defined.

    2. Calculations for all data submitted, fully defined.

3. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.

4. Production and operational data.

5. Calibration procedures and work sheets for sampling equipment.

6. Copies of calibration records for instrumentation.

3.04 COMMISSIONING

A. Provide 15 working days written notice to the Engineer for each commissioning procedure so that the Engineer may witness the each commissioning procedure. The Engineer may witness the performance of any or all each commissioning procedure, at their option.

B. Commissioning shall begin at the conclusion of Startup Testing, wherein the equipment or unit process systems are subjected to full operation using the process flows.

1. On successful completion of Startup, process flows and solids shall be used for commissioning the equipment and unit process systems to show the equipment and unit process systems function properly. Commissioning shall confirm the proper operation of the equipment and unit process systems with process fluids and process solids, adjustments shall be made, and the equipment or unit process systems shall be optimized and brought into compliance with design criteria.

2. The various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Commissioning services for the new facility.

C. The Contractor shall coordinate all Commissioning activities for equipment and unit process systems in accordance with the accepted Plan. The Contractor shall develop a detailed Commissioning plan as part of that Plan that includes the following as a minimum:

1. Description of the overall, general Commissioning process.

2. List of equipment and unit process systems included for Commissioning activities.

3. Detailed Commissioning sequence of activities.

4. Equipment and system boundaries as shown using marked-up P&IDs.

5. Listing of staff and responsibilities for activities.

D. Commissioning Requirements: The following are minimum requirements for completion of Commissioning activities:

1. Commissioning shall show that the equipment and unit process systems are capable of continuous operation using process liquids and solids, chemicals, and utilities; and that the flows, wastewater, operating parameters, and performance requirements have been demonstrated for a minimum of seven days of continuous operation, or the period required in the equipment specifications, whichever is longer.

    a. Shutdowns that occur because of power outages, acts of God, or failure of support systems not part of this contract will not be a cause of failure of the seven days of continuous operation.

2. If the commissioning fails, the contractor will be responsible for redoing the commissioning at no additional cost to the Owner.

E. Documentation Requirements:

1. A Commissioning report shall be prepared and submitted to the Engineer for review and retuned with any exceptions noted. The reports shall include, but not be limited to, the following:

    a. Contractor Review Comments and Approval Page. This page shall include Certification by the preparer that he or she is the person responsible for the test data and the data is authentic and accurate. This page shall include a listing and signature of all witness's to the test. Certification by the Contractor that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that the equipment or unit process systems are suitable for Performance Testing.

    b. Equipment Suppliers Review Comments and Approval Page. This page shall include Certification by the equipment or unit process systems suppliers that the equipment or unit proves systems have been started up properly and operated within the design parameters. Certification by the equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that the equipment or unit process systems are suitable for Performance Testing.

    c. Engineer Review Comments, and Approval Page.

    d. Process, Equipment, and P&IDs Involved in this startup commissioning test.

    e. Commissioning Schedule.

    f. Test Description and Procedures.

1. Equipment or unit process systems tested.

2. Test dates.

3. Electrical Inspection and Tests.

4. Test results.

5. Any repairs or corrections required to obtain acceptable test results.

6. Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

g. Appendix:

1. A summary of all data used in the calculations, including source, formulas with all terms defined.

2. Calculations for all data submitted, fully defined.

3. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.

4. Production and/or operational data.

5. Calibration procedures and work sheets for sampling equipment.

6. Copies of calibration records for instrumentation.

F. Commissioning Documentation and Reports

3.05 PERFORMANCE TESTING

A. Begin a seven day Performance Test after successful commissioning and approval by regulatory agencies including, but not limited to SCDHEC.

END OF SECTION

INDEX TO

SECTION 01 78 33

BONDS

SECTION 01 78 33

BONDS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Preparation and submittal of bonds.

B. Time and schedule of submittals.

1.02 RELATED SECTIONS

A. Document 00 11 16 – Invitation to Bid: 00 21 13 – Instruction to Bidders.

B. Document General Conditions – EJCDC: Performance bond and labor and material payment bonds.

C. Section 01 77 00 –Closeout Procedures: Contract closeout procedures.

D. Section 01 78 23 – Operation and Maintenance Data.

E. Individual Specifications Sections: Bonds required for specific Products or Work.

1.03 FORM OF SUBMITTALS

A. Bind in commercial quality 8–1/2 x 11 appropriately sized, D-ring binders with durable covers.

B. Cover: Identify each binder with typed or printed title BONDS with title of Project; name, address, and telephone number of Contractor and equipment supplier; and name of responsible company principal.

C. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of Product or work item.

D. Separate each bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

E. Provide a summery sheet of all bonds.

1.04 PREPARATION OF SUBMITTALS

A. Obtain bonds executed by responsible Subcontractors, suppliers, and manufacturers, in accordance with timeframes listed herein.

B. Verify documents are in proper form, contain full information, and are notarized.

C. Co–execute submittals when required.

D. Retain bonds until time specified for submittal.

1.05 TIME OF SUBMITTALS

A. For equipment or components of equipment put into service during construction with Owner's permission, submit documents within ten days of Owner's acceptance.

B. Make other submittals within ten days of date of final acceptance of the item or Work, prior to final Application for Payment.

C. For items or Work for which acceptance is delayed beyond date of final completion, submit within ten days of acceptance, listing the date of acceptance as the beginning of the bond period.

END OF SECTION

INDEX TO

SECTION 01 78 36

WARRANTIES

SECTION 01 78 36

WARRANTIES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Preparation and submittal of warranties.

B. Time and schedule of submittals.

1.02 RELATED SECTIONS

A. General Conditions – EJCDC: Warranties and correction of work.

B. Section 01 77 00 – Closeout Procedures: Contract closeout procedures.

C. Section 01 78 23 – Operation and Maintenance Data.

D. Individual Specifications Sections: Warranties required for specific Products or Work.

1.03 FORM OF SUBMITTALS

A. Bind in commercial quality 8–1/2 x 11, appropriately sized, D- ring binders with durable covers.

B. Cover: Identify each binder with typed or printed title WARRANTIES with title of Project; name, address, and telephone number of Contractor and equipment supplier; and name of responsible company principal.

C. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual. Identify each item with the name of Product or work item and the number and title of the specification section in which it is specified.

D. Separate each warranty with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

E. Provide a summery sheet of all warranties.

1.04 PREPARATION OF SUBMITTALS

A. Obtain bonds executed by responsible Subcontractors, suppliers, and manufacturers, in accordance with timeframes listed herein.

B. Verify documents are in proper form, contain full information, and are notarized.

C. Co–execute submittals when required.

D. Retain warranties until time specified for submittal.

1.05 TIME OF SUBMITTALS

A. For equipment or components of equipment put into service during construction with Owner's permission, submit documents within ten days of Owner's acceptance.

B. Make other submittals within ten days of date of final acceptance of the item or Work, prior to final Application for Payment.

C. For items or Work for which acceptance is delayed beyond date of final completion, submit within ten days of acceptance, listing the date of acceptance as the beginning of the warranty period.

END OF SECTION

INDEX TO

SECTION 01 79 00

DEMONSTRATING AND TRAINING

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specifications, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for instructing utilities personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.

2. Training in operation and maintenance of systems, subsystems, and equipment.

1.03 INFORMATION SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' name for each training module. Include outline for each training module.

B. Qualification Data: For instructor, demonstrating qualifications and ability to instruct on maintenance and care of system, equipment, and products.

C. Schedule of Demonstration and Training: Prepare a schedule in tabular form of all demonstration and training required in individual Specification Sections including:

1. Specification Section number and title.

2. Description of required demonstration and training.

D. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.04 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative, experienced in operation and maintenance procedures and training. Manufacturer's sales staff is not acceptable.

B. Pre-instruction Conference: Conduct conference at Project site to review methods and procedures related to demonstration and training.

PART 2 – PRODUCTS

2.01 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Provide trainee manuals.

C. Training Modules: For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Including the following:

a. System, subsystem, and equipment descriptions.

b. Operating standards.

c. Regulatory requirements.

d. Equipment function.

e. Operating characteristics.

f. Limiting conditions.

g. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.

b. Operations manuals.

c. Maintenance manuals.

d. Project record documents.

e. Identification systems.

f. Warranties and bonds.

g. Maintenance service agreement and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.

b. Instructions on stopping.

c. Shutdown instructions for each type of emergency.

d. Operating instructions for conditions outside of normal operating limits.

e. Sequences for electric or electronic systems.

f. Special operating instructions and procedures.

g. A tour of the installation identifying the location of all system components.

4. Operations: Include the following, as applicable:

a. Startup procedures.

b. Equipment or system break-in procedures.

c. Routine and normal operating instructions.

d. Regulation and control procedures.

e. Control sequences.

f. Safety procedures.

g. Instructions on stopping.

h. Normal shutdown instructions.

i. Operating procedures for emergencies.

j. Operating procedures for system, subsystem, or equipment failure.

k. Seasonal and weekend operating instructions.

l. Required sequences for electric or electronic systems.

m. Special operating instructions and procedures.

n. Sequence of operation.

5. Adjustments: Include the following:

a. Alignments.

b. Checking adjustments.

c. Noise and vibration adjustments.

d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.

b. Testing and inspection procedures.

7. Maintenance: Include the following:

a. Inspection of procedures.

b. Types of cleaning agents to be used and methods of cleaning.

c. List of cleaning agents and methods of cleaning detrimental to product.

d. Procedures for routine cleaning.

e. Procedures for preventative maintenance.

f. Procedures for routine maintenance.

g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.

b. Repair instructions.

c. Disassembly; component removal, repair, and replacement; and reassembly instructions.

d. Instructions for identifying parts and components.

e. Review of spare parts needed for operation and maintenance.

f. Product support/service model.

g. Purchasing of replacement parts.

9. Instruction specific to Instrumentation and Controls, Electrical, Lighting Controls, or any other new technology that is integrated with another system: Include the following:

a. Overview and theory.

b. Wiring diagrams, including the one line diagram.

c. Graphics packages and touch screens for the system.

d. Alarms and diagnostics.

e. Reporting functions dynamically and historically.

f. Remote access to the system.

g. Database back-up and maintenance.

h. Replacement and re-programming of replacement parts.

i. Programming.

j. Help files and other troubleshooting documentation.

D. Operation and Maintenance Manuals: Provide appropriate Operation and Maintenance manuals in each training session so that the detail drawings and maintenance activates are outlined and discussed for each application.

PART 3 - EXECUTION

3.01 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module.

B. Set up instructional equipment at instruction location.

3.02 INSTRUCTION

A. Engage qualified instructors to instruct personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Coordinate schedule for all training with Engineer and provide the following:

a. Minimum three weeks notification.

b. Training matrix in calendar format.

c. Training outline for each session.

2. Do not schedule until equipment has been started up, commissioned, and is currently operating in its normal condition.

3. Do not schedule overlapping training sessions.

4. Schedule training sessions for a maximum of four hours per day; afternoons preferred.

5. Provide separate training session on each system for operational/maintenance groups and user groups.

6. Training sessions will be cancelled and rescheduled unless the following documentation is received:

   a. Instruction qualifications.

   b. Evidence that equipment has been started up, commissioned, and is currently operating in its normal condition.

   c. Operation and Maintenance manuals.

C. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION

INDEX TO

SECTION 01 79 01

EQUIPMENT AND SYSTEM
PERFORMANCE AND OPERATIONAL TESTING

SECTION 01 79 01

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section contains requirements for the Contractor's performance in documenting testing work required under this contract. In addition, this section contains requirements the for the Contractor's performance during installed performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems, including structures for watertight construction, provided under this. This section supplements but does not supersede specific testing requirements found elsewhere in this project manual.

B. After equipment has been shown thru functional completion testing to be ready for equipment and process start up, the following outline applies for the MBR process.

1. Startup (clean water testing) is defined as the operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate the operation of the equipment or unit process systems with other equipment that is a part of or a treatment process for the Facility. (24 hours min. generally 3-4 days)

2. Commissioning is defined as the operation of equipment of unit process systems using wastewater, process liquids or process solids, plant support equipment, and plant utilities to demonstrate equipment or unit process systems are capable of processing water or wastewater at specified flows and conditions for a sustained period of operation as required by this section or equipment or unit process systems are ready to begin Performance Testing. (14 days min.)

3. Performance Testing is defined as a test to demonstrate the specified throughout of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees. (7 days)

4. During the performance testing, daily equal volume composite samples from the influent and effluent shall be obtained by the Contractor (or Owner if contractor makes prior arrangements for the owner to assist).

5. These samples will be for the measurement of the following parameters by the contractor:
   a. BOD
   b. TSS
   c. TKN
   d. NH3
   e. TP
   f. TN
   g. Flow

6. The treated effluent shall meet these parameters:
   a.
   b. Parameter Effluent Limits
   c. BOD <5 mg/L
   d. TSS <5 mg/L
   e. TKN <13 mg/L
   f. NH3 <2 mg/L
   g. TP <9 mg/L
   h. TN <20 mg/L

7. Operating period: is defined as a 30 day period that the Owner operates the plant while the contractor provides personnel which are available to answer questions, address operational issues and/or equipment malfunctions/adjustments and similar items during the initial operating period.

C. Performance Testing shall be completed for items of equipment and unit process systems to confirm that the equipment or unit process systems meet the Guaranteed Performance Criteria and the equipment and unit process systems performance criteria specified for the equipment or unit process. Performance Testing shall include testing requires by regulatory agencies or environmental regulations. Performance Testing shall be performed to demonstrate the specified throughput of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees.

D. The information collected shall be used as a basis for determining acceptability of the equipment or unit process systems to meet performance requirements.

E. If any of the equipment or unit process systems fail to meet the specified requirements and guarantees, it shall be the responsibility of the Contractor and equipment suppliers to make the necessary corrections or replacements and repeat the test. This procedure shall be followed until all equipment meets the guaranteed performance requirements and has been accepted by the Engineer.

F. All modifications required to meet performance criteria, and all retesting shall be performed at no additional cost to the Owner. This includes

payment of all engineering fees and expenses associated with the Owner's Consultant's observation of the retest.

G. Corrective work resulting from failed performance shall be immediately scheduled and work shall commence within one week unless there is supportable proof that this is impossible. In that case, the Contractor shall request in writing an extension of time indicating the exact time the corrective work will begin.

H. In the event that the equipment of unit process systems do not meet pass/fail criteria of the Performance Guarantees within the extension period stipulated in the Contract, the Engineer shall determine acceptance per the provisions included in the Contract.

1.02 QUALITY ASSURANCE

A. CONTRACTOR'S QUALITY ASSURANCE MANAGER:

1. The Contractor shall appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise the Contractor's quality assurance program. The Quality Assurance Manager shall have at least five years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, process, piping systems, and MBR systems. The quality assurance program shall include:

a. A testing plan setting forth the sequence in which all testing work required under this project manual will be implemented.

b. A documentation program to record the results of all equipment and system tests.

c. An installed performance testing program for all piping, mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this contract.

d. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this contract.

e. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this contract.

f. A testing schedule conforming to the requirements specified in paragraph 01 79 01-2.02 C.

1. For the purposes of this section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as

their operation or function complements, protects or controls the operation or function of the others. The Quality Assurance Manager shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this section.

B. CALIBRATION:

1. All test equipment (gages, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus two percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.

2. Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than two inches shall be calibrated in situ using either the total count or dye dilution methods. Gas flow meters installed in piping systems with diameters greater than six inches shall be calibrated in situ using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than ten percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus two percent.

C. REFERENCES:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document

before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/ASME B40.1	Gauges Pressure Indicating Dial Type—Elastic Element
ASTM E77	Method for Verification and Calibration of Liquid-in-Glass Thermometers
ASHRAE 41.8	Standard Methods of Measurement of Flow of Gas
Dye Dilution Calibration Method	Flow Measurements in Sanitary Sewers By Dye Dilution, Turner Designs Mountain View, California,
	Flow Measurement in Sewer Lines by the Dye Dilution Method, Journal of the Water Pollution Control Federation, Vol. 55, Number 5, May, 1983, pg. 531
	Flow Measurement in Open Channels and Closed Conduits, Vol 1, U.S. Department of Commerce, National Bureau of Standards, pg. 361
	Techniques of Water-Resources Investigations of the United States Geological Survey, Chapter 16, Measurement of Discharge Using Tracers

1.03 SUBMITTALS

A. Submittal shall consist of the following:

1. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of paragraph 01 79 01-2.02 A, including:

   a. Proposed plan for documenting the calibration of all test instruments.

   b. Proposed plan for calibration of all instrument systems, including flow meters and all temperature, pressure, weight, and analysis systems.

   c. Sample forms for documenting the results of field pressure and performance tests.

2. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.

3. Preoperational check-out procedures, reviewed and approved by the respective equipment manufacturers.

4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by the Contractor for the systematic testing of all equipment and systems installed under this contract.

5. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this contract.

6. A schedule establishing the expected time period (calendar dates) when the Contractor plans to commence operational testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place.

7. A summary of the Quality Assurance Manager's qualifications, showing conformance to paragraph 01 79 01-1.02 A requirements.

PART 2 – PRODUCTS

2.01 GENERAL

A. The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Engineer will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and accepted.

2.02 DOCUMENTATION

A. DOCUMENTATION PLANS:

1. The Contractor shall develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.

2. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test, and signature spaces for the Engineer's witness and the Contractor's quality assurance manager. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:

   a. Metallurgical tests
   b. Factory performance tests
   c. Accelerometer recordings made during shipment

d. Field calibration tests[1]
e. Field pressure tests[1]
f. Field performance tests[1]
g. Field operational tests[1]

3. Section 01 99 90 contains samples showing the format and level of detail required for the documentation forms. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable documentation forms for all systems and items of equipment shall be produced for review by the Engineer as a condition precedent to the Contractor's receipt of progress payments in excess of 50 percent of the contract amount. Once the Engineer has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this contract.

B. TEST PLANS:

1. The Contractor shall develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number. Each device or control station to be manipulated or observed during the test procedure, and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors' and manufacturers' representatives to be present and expected test duration. As a minimum, the test plans shall include the following features:

a. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device.

b. Calibration of all analysis instruments and control sensors.

c. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the project manual.

[1]Each of these tests is required even though not specifically noted in detailed specification section.

d. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.

2. Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

3. As a condition precedent to receiving progress payments in excess of 75 percent of the contract amount, or in any event, progress payments due to the Contractor eight weeks in advance of the date the Contractor wishes to begin any testing work (whichever occurs earliest in the project schedule), the Contractor shall have submitted all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this contract. The Contractor shall reproduce the plans in sufficient number for the Contractor's purposes and an additional ten copies for delivery to the Engineer. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Engineer.

C. TESTING SCHEDULE:

1. The Contractor shall produce a testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Contractor's construction schedule. The schedule shall show the contemplated start date, duration of the test and completion of each test. The test schedule shall be submitted no later than four weeks in advance of the date testing is to begin. The Engineer will not witness any testing work for the purpose of acceptance until the Contractor has submitted a schedule to which the Engineer takes no exception. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of this project manual.

a. The cost for the labor to conduct the testing shall be included in the lump sum cost of the project. The cost of test media, chemicals, electric power, and natural gas will be included in the lump sum cost of the project. The cost of test media, chemicals, electric power, and natural gas for any retesting will be accomplished at no additional cost to the Owner.

b. The tests shall be conducted in accordance with applicable industry standard techniques.

1. Local and remote on-site instrumentation equipment may be used to record test data where it is determined to be sufficiently accurate to obtain the necessary data for the performance evaluation.

2. Where special analysis and emissions testing are required, or other resources are needed for testing, the Contractor shall be responsible for providing them.

3. Where local instrumentation is available, manual logging of the data shall be done in conjunction with the instrumentation readings to verify remote instrumentation readings.

4. Any necessary adjustment to test results shall be made by use of standard formulas and relationships.

2. All data values shall be reported both as "measured" and corrected as required by the performance or regulations. Data values shall be stated in the engineering units noted for guaranteed performance or regulatory compliance.

3. Performance Testing shall be witnessed by the Engineer and Owner.

PART 3 – EXECUTION

3.01 GENERAL

A. The Contractor's quality control manager shall organize teams made up of qualified representatives of equipment suppliers, subcontractors, the Contractor's independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this contract. The objective of the testing program shall be to demonstrate, to the Engineer's complete satisfaction, that the structures, systems, and equipment constructed and installed under this contract meet all performance requirements and the facility is ready for the commissioning process to commence. In addition, the testing program shall produce baseline operating conditions for the Owner to use in a preventive maintenance program.

3.02 CALIBRATION OF FIXED INSTRUMENTS

A. Calibration of analysis instruments, sensors, gages, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system performance acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the Engineer.

B. All analysis instruments, sensors, gages, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All

analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration as a condition precedent to commissioning.

3.03 START UP TESTS

A. GENERAL:

1. Tests shall consist of the following:

a. Pressure and leakage tests.

b. Electrical testing as specified in the applicable section.

c. Wiring and piping, individual component, loop, loop commissioning, and tuning testing as described in the applicable section.

d. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.

e. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual.

2. In general, tests for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the Engineer after receipt of a written request, complete with justification of the need for the change in sequence.

B. PRESSURE AND LEAKAGE TESTS:

1. Pressure and leakage tests (including air tests for gravity lines) shall be conducted in accordance with applicable portions of these. All acceptance tests shall be witnessed by the Engineer. Evidence of successful completion of the pressure and leakage tests shall be the Engineer's signature on the test forms prepared by the Contractor.

C. FUNCTIONAL CHECKOUT:

1. Prior to energization (in the case of electrical systems and equipment), all circuits shall be rung out and tested for continuity and shielding in accordance with the procedures required in elsewhere.

D. COMPONENT CALIBRATION AND LOOP TESTING:

1. Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested in accordance with the procedures required in elsewhere.

E. ELECTRICAL RESISTANCE:

1. Electrical resistance testing.

F. PREOPERATIONAL TESTS:

1. Preoperational tests shall include the following:

a. Alignment of equipment using reverse dial indicator method.

b. Preoperation lubrication.

c. Tests per the manufacturers' recommendations for prestart preparation and preoperational check-out procedures.

G. FUNCTIONAL TESTS:

1. GENERAL: Once all affected equipment has been subjected to the required preoperational check-out procedures and the Engineer has witnessed and has not found deficiencies in that portion of the work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these specifications. If available, plant effluent may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the Owner. Disposal methods for test media shall be subject to review by the Engineer. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the Owner to enter in a preventive maintenance system.

Test results shall be within the tolerances set forth in the detailed specification sections of this project manual. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the Engineer and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Engineer may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Engineer may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the Owner. Otherwise, the costs shall be borne by the Contractor. Where the results of any functional test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by the Contractor at his expense.

The Contractor shall provide, at no expense to the Owner, all power, fuel, compressed air supplies, water, and chemicals, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work required to complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.

2. RETESTING: If under test, any portion of the work should fail to fulfill the contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the work as are affected thereby, shall, unless otherwise directed by the Engineer, be repeated within reasonable time and in accordance with the specified conditions. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner, including the costs of the Engineer, as a result of repeating such tests.

3. POSTTEST INSPECTION: Once functional testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Engineer. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Engineer at no cost to the Owner.

3.04 COMMISSIONING

A. The Contractor shall provide system operation testing. After completion of all start up testing, the Contractor shall fill all process units and process systems, except those employing domestic water, oil, air, or chemicals,

with plant effluent water. All domestic water, oil, air, and chemical systems shall be filled with the specified fluid.

B. Upon completion of the filling operations, the Contractor shall circulate water through the completed facility for a period of not less than 48 hours, during which all parts of the system shall be operated as a complete facility at various loading conditions, as directed by the Engineer. The testing period shall commence after this initial period of variable operation. This testing period shall be 14 days. Should the testing period be halted for any reason related to the facilities constructed or the equipment furnished under this contract, or the Contractor's temporary testing systems, the testing program shall be repeated until the specified continuous period has been accomplished without interruption. All process units shall be brought to full operating conditions, including temperature, pressure, and flow.

C. As-built documents of facilities involved shall be accepted and ready for turnover to the Owner at the time of the testing.

3.05 PERFORANCE TESTING

Performance Testing is defined as a test to demonstrate the specified throughout of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees. (7 days).

3.06 INDEPENDENT TESTING ORGANIZATION

A. The Contractor shall be responsible for the contracting of an Independent Testing Organization and shall be responsible for payment of their services.

B. The testing organization will be under the direct supervision of the Contractor, with input from the equipment and unit process systems suppliers, and the Engineer.

1. All instructions, and any other type contact or correspondence shall be through the Contractor.

2. The Contractor shall submit qualifications for the Independent Testing Organization to the Engineer for review.

3.07 TEST COORDINATION

A. Where required, the Contractor shall furnish an authorized competent representative of the equipment or unit process systems suppliers to attend and coordinate the test program.

1. Test coordinator scope of services shall include preliminary instructions and orientation of Contactor's personnel prior to the actual test, instructions throughout the test period, recommended variations, if required, to assure validity of the test, and posttest instructions for system shutdown or continued operation as required by the Engineer.

2. Instrument readings and other test data shall be tabulated by the Contractor.

3. Data sheet copies shall be submitted to the Engineer for review and analysis at the end of each testing day.

B. The Contractor will work closely with the equipment or unit process systems supplier to aid in coordination of required plant functions involving systems not furnished by the suppliers of the equipment or unit process systems being tested. This shall include but is not limited to support equipment, utilities, and support processes.

3.08 TEST METHODS

A. Methods of data collections and analysis used for Performance Testing to show compliance shall be as required by regulatory agencies, industry standards and as specified with the equipment or unit process systems.

3.09 RESPONSIBILITIES

A. Responsibility for performance testing shall be with the Contractor. These assignments shall be detailed and assigned as part of the detailed test plan.

B. Manual logging of operations parameters shall be the responsibility of the Contractor, equipment, or unit process systems supplier.

C. Collections of samples shall be the responsibility of the Independent Testing Organization and may be performed by the Independent Testing Organization.

D. The Independent Testing Organization shall be responsible for tagging all samples, and for the orderly transfer to the Independent Testing Organization.

1. Both the Contractor and the testing organization shall be responsible for completing a Chain-of-Custody log of all samples.

E. All laboratory testing of samples shall be the responsibility of the Independent Testing Organization and shall be performed at the testing organization's laboratory. The Contractor shall be responsible for operating the equipment or unit process systems.

3.10 REPORTS

A. Reports are required for all tests specified in the individual specifications for equipment and unit process. Four copies of preliminary test reports shall be supplied to the Engineer for review and returned with any applicable notes.

B. Tests reports shall be submitted no later than ten calendar days after testing ends. The Contractor shall assist and furnish required information in a timely manner including operating data sheets.

C. The reports shall include, but not be limited to, the following:

1. Cover. Including name and location of the plant, the equipment or unit process systems tested, name and address of the testing organization, and dates of the test.

2. Certification. A page including a certification by the report preparer that he or she is the person responsible for the test data, and one by the Contractor or equipment or unit process systems certifying authenticity and accuracy of the report.

3. Table of Contents.

4. Introduction. Pertinent background information shall be presented in this Section. The information shall include, but not be limited to, the following:

   a. Equipment or unit process systems tested.
   b. Test purpose.
   c. Name and address of suppliers, and testing organization.
   d. Test dates.
   e. Items of performance criteria tested.
   f. Names of persons present for test.
   g. Any other important background information.

5. Summary. A comprehensive summary of the test results with sufficient information and data necessary to evaluate the process with respect to the applicable performance specifications. This information shall include, but not be limited to, the following:

   a. A summary of the test results.

   b. Comparison of test results with required performance criteria.

c. Process and operation data or parameters that can be used to verify operation at performance criteria.

d. A description and results of any analyses of samples collected during the test that supports the test results.

e. Discussion of errors, both real and apparent, in the test.

6. Methods. A description of the sampling and analytical methods used.

7. Operation. Facility Operation during Testing shall contain:

a. Presentation of the process data for the test, with calculations where necessary to show the solids throughput or production to demonstrate that the operating conditions are sufficiently representative of those required for testing. Calculations may be included in the Appendix.

b. Process and control equipment flow diagram.

8. Appendix.

a. A summary of all data used in the calculations, including source, formulas with all terms defined.

b. Calculations for all data submitted, fully defined.

c. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.

d. Laboratory report, complete with analytical data sheets and chain of custody list.

e. Production and/or operational data.

f. Calibration procedures and work sheets for sampling equipment.

g. Copies of calibration records for instrumentation.

h. Pertinent correspondence concerning test.

i. Any other information necessary to assist the Owner in making a determination of compliance with the contract documents or to assist the Agency in making a determination of compliance with Federal, State, and Local regulations.

END OF SECTION

SECTION 01 99 90

REFERENCE FORMS

The forms listed below and included in this section are referenced from other sections of the project manual (not all forms may be referenced or used):

Form No.	Title
01300–A	Submittal Transmittal Form
01660–A	Equipment Test Report Form
01730–A	Operation and Maintenance Transmittal Form
01730–B	Equipment Record Form
01730–C	Equipment Record Form
09900–A	Coating System Inspection Checklist
11000–A	Manufacturer's Installation Certification Form
11000–B	Manufacturer's Instruction Certification Form
11000–C	Unit Responsibility Certification Form
11002–A	Rigid Equipment Mount Installation Inspection Checklist
11060–A	Motor Data Form
16000–A	Wire and Cable Resistance Test Data Form
16000–B	Installed Motor Test Data Form
16000–C	Dry Transformer Test Data Form
16000–D	Motor Control Center Test Form
16000–E	Medium Voltage Motor Starter Test Form
16000–F	Medium Voltage Switchgear Test Form
16000–G	Protective Relay Test Form
16000–H	Low Voltage Switchgear Test Form
16000–I	Medium Voltage Load Interrupter Switch Test Form
16000–J	Liquid–Filled Transformer Test Form
16000–K	Automatic Transfer Switch Test Form
16000–L	Neutral Grounding Resistor Test
17000–A	Loop Wiring and Insulation Resistance Test Data Form
17000–B	Control Circuit Piping Leak Test Form
17000–C	Controller Calibration Test Data Form
17000–D	Panel Indicator Calibration Test Data Form
17000–E	Recorder Calibration Test Data Form
17000–F	Signal Trip Calibration Test Data Form
17000–G	Field Switch Calibration Test Data Form
17000–H	Transmitter Calibration Test Data Form
17000–I	Miscellaneous Instrument Calibration Test Data Form
17000–J	Individual Loop Test Data Form
17000–K	Loop Commissioning Test Data Form

01300–A. SUBMITTAL TRANSMITTAL FORM:

SUBMITTAL TRANSMITTAL

Submittal Description: _____ Submittal No:[1] _____

Spec Section: _____

	Routing	Sent	Received
OWNER:	Contractor/CM		
PROJECT:	CM/Engineer		
	Engineer/CM		
CONTRACTOR:	CM/Contractor		

We are sending you ☐ Attached ☐ Under separate cover via _____

☐ Submittals for review and comment ☐ Product data for information only

Remarks: _____

Item	Copies	Date	Section No.	Description	Review Action [a]	Reviewer initials	Review comments attached

[a] **Note: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected**
Attach additional sheets if necessary.

Contractor

Certify either A or B:

☐ A. We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

☐ B. We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

[1]See paragraph 01300-4.0 A, Transmittal Procedure.

No.	Deviation

Certified by: _____

Contractor's Signature

01660–A. EQUIPMENT TEST REPORT FORM:

NOTE: This example equipment test report is provided for the benefit of the Contractor and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.

CITY OF SAMPLE

EXAMPLE WATER TREATMENT PLANT
STAGE IV EXPANSION PROJECT

ABC Construction Company, Inc., General Contractor
XYZ Engineering, Inc., Construction Manager

EQUIPMENT TEST REPORT

Equipment Name: Sludge Pump 2
Equipment Number: P25202
Specification Ref: 11390
Location: East Sedimentation Basin Gallery

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
PREOPERATIONAL CHECKLIST				
Mechanical				
Lubrication				
Alignment				
Anchor bolts				
Seal water system operational				
Equipment rotates freely				
Safety guards				
Valves operational				
Hopper purge systems operational				
Sedimentation tank/hopper clean				
O&M manual information complete				
Manufacturer's installation certificate complete				
Electrical (circuit ring–out and high–pot tests)				
Circuits:				
Power to MCC 5				
Control to HOA				
Indicators at MCC:				
Red (running)				
Green (power)				
Amber (auto)				
Indicators at local control panel				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
Wiring labels complete				
Nameplates:				
MCC				
Control station				
Control panel				
Equipment bumped for rotation				
Piping Systems				
Cleaned and flushed:				
Suction				
Discharge				
Pressure tests				
Temporary piping screens in place				
Instrumentation and Controls				
Flowmeter FE2502F calibration				
Calibration Report No.				
Flow recorder FR2502G calibrated against transmitter				
VFD speed indicator calibrated against independent reference				
Discharge overpressure shutdown switch calibration				
Simulate discharge overpressure Shutdown				
FUNCTIONAL TESTS				
Mechanical				
Motor operation temperature satisfactory				
Pump operating temperature satisfactory				
Unusual noise, etc?				
Pump operation: 75 gpm/50 psig				
Measurement:				
Flow				
Pressure:		Test gage number:		
Alignment hot				
Dowelled in				
Remarks:				

Electrical				
Local switch function:				
Runs in *HAND*				
No control power in *OFF*				
Timer control in *AUTO*				
Overpressure protection switch PS2502C functional in both *HAND* and *AUTO*				
Overpressure protection switch PS2502C set at 75 psig				

PLC 2500 set at 24–hour cycle, 25 min *ON*				
OPERATIONAL TEST				
48–hour continuous test. Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional				

RECOMMENDED FOR BENEFICIAL OCCUPANCY

_____

Construction Manager_____ Date _____

ACCEPTED FOR BENEFICIAL OCCUPANCY

_____

Owner's Representative_____ Date _____

01730–A. OPERATION AND MAINTENANCE TRANSMITTAL FORM:

Date: _____ Submittal No:[2] _____

To: _____ Contract No: _____

_____ Spec. Section: _____

_____ Submittal Description: _____

_____ From: _____

Attention: _____ _____

Checklist	Contractor		Construction manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Start–up, shutdown, and post-shutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Troubleshooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance man–hours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				

[2]See paragraph 01300-4.0 A, Transmittal Procedure.

23. Testing equipment and special tool information				

Remarks: _____

_____

Contractor's Signature

01730–B. EQUIPMENT RECORD FORM:

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO.	SHOP DWG NO.	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS	D	W	M	Q	S	A	Hours
LUBRICANTS: RECOMMENDED:							
ALTERNATIVE:							
MISC. NOTES:							

RECOMMENDED SPARE PARTS			
PART NO	QUAN	PART NAME	COST

ELECTRICAL NAMEPLATE DATA			
EQUIP			
MAKE			
SERIAL NO.		ID NO.	
MODEL NO.		FRAME NO.	
HP	V	AMP	HZ
PH	RPM	SF	DUTY
CODE	INSL. CL	DES	TYPE
NEMA DES	C AMB	TEMP RISE	RATING
MISC.			
MECHANICAL NAMEPLATE DATA			
EQUIP			
MAKE			
SERIAL NO.		ID NO.	
MODEL NO.		FRAME NO.	
HP	RPM	CAP	SIZE
TDH	IMP SZ	BELT NO.	CFM
PSI	ASSY NO.	CASE NO.	

				MISC

01730–C. EQUIPMENT RECORD FORM:

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO.	SHOP DWG NO.	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS	D	W	M	Q	S	A	Hours

09900–A COATING SYSTEM INSPECTION CHECKLIST

Area or Structure to be coated: _____

Coating System (from paragraph 09900–2.01): _____

Date: _____

Contract Package No. _____

Coating Type _____

Coating System Manufacturer (CSM): _____

Coating System Applicator: _____

General Contractor: _____

Step 1: Completion of Cleaning and Substrate Decontamination Prior to Abrasive Blast Cleaning.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 2: Installation of Protective Enclosure of Structure or Area and Protection of Adjacent Surfaces or Structures NOT TO BE COATED.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 3: Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ventilation System in Structure or Area as it applies to application and curing requirements for the coating system.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 4: Completion of Surface Preparation for Concrete and Metallic Substrates to Be Coated.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 5: Completion of Primer Application.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 6: Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 7: Completion of Concrete Filler/Surface Application to Concrete.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 8: Completion of First Finish Coat Application and of Coating System Detail Treatment at Transitions or Terminations.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 9: Completion of Second Finish Coat Application and of Coating System Detail Treatment at Transitions and Terminations.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 10: Completion of Full and Proper Cure of Coating System.

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 11: **Completion of Adhesion Testing of Cured Coating System on Concrete and Metallic Substrates and Acceptance of Holiday (Continuity) Testing of Coating System on Concrete and Metallic Substrates.**

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 12: **Completion of Localized Repairs to Coating System Following Adhesion and Continuity Testing.**

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

Step 13: **Final Acceptance of Coating System Installation Including Final Clean–Up of the Work Site Complying with Specification Requirements and the CSM's Quality Requirements.**

Representing	Name	Signature	Date
Contractor			
Coating System Applicator			

11000–A. MANUFACTURER'S INSTALLATION CERTIFICATION FORM:

Contract No: _____ Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments: _____

_____

_____

_____

_____

_____ _____

Date Manufacturer

_____

Signature of Authorized Representative

_____ _____

Date Contractor

_____

Signature of Authorized Representative

11000–B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM:

Contract No: _____ Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)	
Start–up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others:	
Maintenance Check List (check appropriate spaces)	
Described normal oil changes (frequency)	
Described special tools required	
Described normal items to be reviewed for wear	
Described preventive maintenance instructions	
Described greasing frequency	
Others:	

_____ _____

Date Manufacturer

_____

Signature of Authorized Representative

_____ _____

Date Signature of Owner's Representative

_____ _____

Date Signature of Contractor's Representative

11000–C. UNIT RESPONSIBILITY CERTIFICATION FORM

(Project Title)

CERTIFICATE OF UNIT RESPONSIBILITY
for Specification Section _____

(Section title)

In accordance with paragraph 11000–1.02 C of the contract documents, the undersigned manufacturer of driven equipment ("manufacturer") accepts unit responsibility for all components of equipment furnished to the Project under specification Section_____ ,_and for related equipment manufactured under Sections___ ____, _____, and _____ .

We have reviewed the requirements for Sections 11000 (and 11050 where applicable) and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this specification Section _____ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this specification Section _____ due to incompatibility of any components covered under this Certificate of Unit Responsibility.

Our signature on this Certificate of Unit Responsibility does not obligate us to take responsibility for, nor to warrant the workmanship, quality, or performance of related equipment provided by others under specification Sections _____, _____, and _____. Our obligation to warranty all equipment provided by us shall remain unaffected.

_____	_____
Notary Public	Name of Corporation
_____	_____
Commission expiration date	Address
Seal:	By: _____
	Duly Authorized Official
	_____
	Legal Title of Official
	Date: _____

11002–A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

(CLIENT, PROJECT NAME)

Equipment Tag No.: _____ Date: _____

Grout Product Name and Type: _____

Grouting System Manufacturer: _____

Grouting Application Contractor: _____

General Contractor: _____

Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Millwright

Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 3: Equipment Leveling.

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Millwright

Step 4: **Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED**

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 5: **Preparation and Construction of Forms and Epoxy Grout Filling Standpipes**

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 6: **Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ambient Conditions as They Apply to Application and Curing Requirements for the Grouting System**

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

Step 7: Epoxy Grout Installation

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 8: Completion of Full and Proper Cure of Epoxy Grout

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

Step 9: Completion of Localized Repair of Grout Voids

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

Step 10: **Final Acceptance of Grouting System Installation Including Final Clean–Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements**

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

11060–A. MOTOR DATA FORM:

Equipment Name_____ Equipment No(s) _____

Project Site Location _____

Nameplate Markings

Mfr:		Mfr Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb Temp Rating:	ºC

Time rating:		Design Letter:	
	(NEMA MG1–10.35)		(NEMA MG–1.16)
KVA Code Letter:		Insulation Class:	

The following information is required for explosion–proof motors only:

A. Approved by UL for installation in Class _____, Div _____, Group _____

B. UL frame temperature code ____ (NEC Tables 500–8B)

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency _____
(Paragraph 11060–2.04 G)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure:			Enclosure Material:		
Temp Rise:	ºC (NEMA MG1–12.41,42)				
Space Heater included?	☐ Yes	☐ No	If Yes:	Watts	Volts
Type of motor winding over–temperature protection, if specified:					

Provide information on other motor features specified:

_____

16000–A. WIRE AND CABLE RESISTANCE TEST DATA FORM:

Wire or Cable No.:_____ Temperature, °F _____

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7	

.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000–B. INSTALLED MOTOR TEST FORM:

Motor Equipment Number _____ Date of test _____

Equipment Driven _____

MCC Location _____

				Ambient temp	°F
Resistance:					
Insulation resistance phase–to–ground megohms:					
Phase A		Phase B		Phase C	
Current at Full Load:					
Phase		Current, amps			
Phase		Current, amps			
Phase		Current, amps			
Thermal Overload Device:	Manufacturer/catalog #		Amperes		
Circuit breaker (MCP) setting:					

Motor Nameplate Markings:

Mfr		Mfr Model		Frame		HP	
Volts		Phase		RPM		Service factor**	
Amps		Freq		Ambient temp rating		°C	
Time rating			Design letter**				
	(NEMA 1–10.35)			(NEMA MG–1.16)			
Code letter			Insulation class				

**Required for 3–phase squirrel cage induction motors only.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000–C. DRY TRANSFORMER TEST DATA FORM:

(Note: Use Data Form for dry type transformers with voltage rating of 600 Vac or less and sizes to 167 kVA single phase and 500 kVA three phase. Use NETA Test Forms and Test Procedures for higher voltages and larger transformers.)

Equipment Tag No.: _____ Temperature Rating: _____

Description/Location: _____ Feeder size/Source: _____

Primary Voltage: ____ Secondary Voltage: ____ Winding Connection: _____

A. VISUAL INSPECTION

Transformer Inspection	Pass	Fail	Note
1. Nameplate data as specified			
2. Mechanical condition			
a. Free of dents and scratches			
b. Anchored properly			
c. Shipping brackets removed			
d. Spacing from wall per nameplate			
3. Grounding *			
a. Equipment grounding			
b. System grounding			

B. INSULATION–RESISTANCE TESTS:

Perform tests with calibrated megohmeter. Apply 1000 Vdc test voltage for 60 seconds and record readings in megohms at 30–seconds and 60–seconds intervals.

Test Group	Resistance between		30–second reading	60–second reading	Absorption Ratio Index 60–sec. / 30–sec.
Primary Winding to ground	A	GRD			
	B	GRD			
	C	GRD			
Secondary Winding to ground with * N–G Bond removed	a	GRD			
	b	GRD			
	c	GRD			
Primary Winding to Secondary Winding	A	a			
	B	b			
	C	c			

Submit resistance readings to the Construction Manager immediately after the tests that are less than the manufacturer's recommended value or less than 10–megohms. Record the Absorption Ratio Index values for future reference. Ratio must be 1.0 or greater, with infinity (∞) equal to 1.0.

Contractor Representative Certified: _____ Date _____

Owner Representative Witnessed:_____ Date _____

16000–D. MOTOR CONTROL CENTER TEST FORM:

Equipment No. _____ Ambient room temperature _____

Location _____

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations.

B. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)			
Phase		Phase	
A–GRD		A–B	
B–GRD		B–C	
C–GRD		C–A	

2. Set the circuit breaker in the starter unit to comply with the requirements of NEC, Article 430–52 and Table 430–152.

3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000–E. MEDIUM VOLTAGE MOTOR STARTER TEST FORM:

Equipment No. _____

Location _____

Room Temperature _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro–ohms)

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro–ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Perform minimum pickup voltage tests on trip and close coils.

4. Motor RTDs shall be tested by using a hot oil bath. The temperature at which the sensor trips shall be recorded for each RTD.

5. The Contactor shall be tripped by operation of each protective device.

16000–F. MEDIUM VOLTAGE SWITCHGEAR TEST FORM:

Equipment No. _____

Location _____

Room Temperature _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro–ohms)

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro–ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Perform minimum pickup voltage tests on trip and close coils.

4. Verify the instrument transformer ratios. Check the transformer's polarity electrically.

5. The Contactor shall be tripped by operation of each protective device.

16000–G. PROTECTIVE RELAY TEST FORM:

Location _____

Switchgear Breaker No. _____

Protective Relay Description _____

The protective relays shall be tested in the following manner:

1. Each protective relay circuit shall have its insulation resistance tested to ground.

2. Perform the following tests on the specified relay setting:

   a. Pickup parameters on each operating element.

   b Timing test shall be performed at three points on the time dial curve.

   c. Pickup target and seal–in units.

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 16000–1.05 B.

16000–H. LOW VOLTAGE SWITCHGEAR TEST FORM:

Equipment No. _____

Location _____

Room Temperature _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro–ohms)

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro–ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Minimum pickup current shall be determined by primary current injection.

4. Long time delay shall be determined by primary injection at three hundred percent (300%) pickup current.

5. Short time pickup and time delay shall be determined by primary injection of current.

6. Instantaneous pickup current shall be determined by primary injection.

7. Trip unit reset characteristics shall be verified.

8. Auxiliary protective devices, such as ground fault or under voltage relays, shall be activated to ensure operation of shunt trip devices.

16000–I. MEDIUM VOLTAGE LOAD INTERRUPTER SWITCH TEST FORM:

Equipment Number _____

Location _____

Date _____

1. Measure switch blade resistance (micro–ohms).

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro–ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 16000–2.06 B.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000–J. LIQUID–FILLED TRANSFORMER TEST FORM:

Equipment Number _____

Location _____

Date/Weather Conditions _____

A. Perform the "Insulation–Resistance Test" and "Dielectric Absorption Test" using Form 16000–C, Dry Transformer Test Data Form.

B. Perform an applied voltage (low frequency dielectric) test in accordance with ANSI C57.12.90, paragraph 10.5, Applied Voltage Test. Applied voltage levels shall be 75 percent of recommended factory test levels or recommended test levels of ANSI C57.12.00, Table 5.

C. Insulating oil shall be sampled and shall be laboratory tested for the following:

1. Dielectric strength.

2. Acid neutralization.

3. Interfacial tension.

4. Color.

5. Power factor.

D. Perform a turns ratio test between the windings for all tap positions.

E. The temperature and pressure switches shall be tested using a hot oil bath and air pump.

The results shall be recorded and signed by the Contractor and Construction Manager. A copy shall be given to the Construction Manager in accordance with paragraph 16000–2.06 D. Any readings which are abnormal to ANSI industry standards shall be reported to the Construction Manager.

16000–K. AUTOMATIC TRANSFER SWITCH TEST FORM:

Equipment Number _____

Location _____

Date _____

1. Perform an insulation resistance test (1000 volts DC for 1 minute):

Phase	A		B		C		
Pole to ground							megohms
Pole to pole	AB		BC		CA		megohms

2. Perform the following operations and initial:

   a. Manual transfer _____

   b. Loss of normal power; _____sec delay

   c. Return to normal power; _____sec delay

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 16000–2.06 B.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000–L. NEUTRAL GROUNDING RESISTOR TEST:

Equipment No. _____

Location _____

The pickup and time delay setting on the ground fault relay shall be set in accordance with Section 16431.

1. The transformer neutral insulation resistance shall be measured with and without the grounding resistor connected to insure no parallel ground paths exist.

2. The protective relay pickup current shall be determined by injecting test current into the current sensor. The pickup current should be within 10 percent of the dial setting. Record the dial setting and actual pickup tie.

3. The relay timing shall be tested by injecting 150 and 300 percent of pickup current into the current sensor. The relay timing shall be in accordance with the manufacturer's published time–current characteristic curves. Record the relay timing at 150 and 300 percent of pickup current.

4. The circuit interrupting device shall be operated by operating the relay.

The results shall be recorded and signed by the Contractor and Construction Manager. A copy shall be given to the Construction Manager in accordance with paragraph 16000–2.06 B.

17000–A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM:

Loop No.: _____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	Panel Tie	Field TB	Continuity Resistance [a]		Insulation Resistance [b]			
			Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			—	(A/SH)				
B			(A/B)	—				
C			(A/C)	—				
D			(A/D)	—				
etc.								

NOTES:

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–B. CONTROL CIRCUIT PIPING LEAK TEST FORM:

Loop No.:_____

List tubing associated with loop in table below. Make applicable measurements after isolating any air consuming pilots from circuit.

Tube No.	Tubing Equivalent Length of 1/4–Inch Copper[a]	Test Period (seconds)	Permitted Pressure Drop (psi)[b]	Measured Pressure Drop (psi)
A				
B				
C				
D				
Etc.				

NOTES:

a. Convert actual tubing and air motor volume to equivalent 1/4–inch copper tubing.

b. Pressure drop shall not exceed 1 psi per hundred feet 1/4–inch tubing per 5 seconds.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–C. CONTROLLER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____ Process Variable (PV) Scale: _____

Output: _____ Output Scale: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

Connect output to PV for following tests:

Set Point (SP) Indicator Accuracy			Output Meter Accuracy			Controller Accuracy		
SP	PV Reading	Expected % Dev.	Actual Reading	Expected Reading	Actual % Dev.	Output	Output	% Dev.
(0%)								
(50%)								
(100%)								
% Deviation Allowed:				% Deviation Allowed:			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

17000–D. PANEL INDICATOR CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–E. RECORDER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____ Chart: _____

Scale: _____ Range: _____

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–F. SIGNAL TRIP CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

Set Point(s): _____

After setting set point(s), run signal input through entire range and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–G. FIELD SWITCH CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make & Model No.: _____ Serial No: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–H. TRANSMITTER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM:

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–J. INDIVIDUAL LOOP TEST DATA FORM:

Loop No.: _____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:
(Attach test form 17000–A)

b. Instrumentation tubing/piping tested:
(Attach test form 17000–B)

c. Instruments calibrated:
(Attach test forms 17000–C through I)

d. List step–by–step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000–K. LOOP COMMISSIONING TEST DATA FORM:

Loop No.: _____

a. Loop tested:
(Attach test form 17000–J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4–amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2–pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 – PV – Connections:

Pen 2 – Output – Connections:

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

INDEX TO

SECTION 02 30 00

SUBSURFACE INVESTIGATION

SECTION 02 30 00

SUBSURFACE INVESTIGATION

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section includes subsurface data logs for information only.

1.02 SOIL INVESTIGATION DATA

A. Subsurface data logs and geotechnical report are available for information only. Actual conditions may vary. If bidders are not satisfied with accuracy and completeness of all available data, they are at liberty to make borings or perform soil investigation work for their own use at its expense. If Contractor chooses to perform his own investigation, work shall be coordinated with the Owner and paid for by the Contractor. Any results from Contractor's investigation shall be shared promptly with the Owner and Engineer. Owner reserves the right to share Contractor's investigation data with other potential bidders if information could affect bidding process.

B. The boring logs and test results are for information of the Contractor. Owner and Engineer assume no responsibility for the information.

PART 2 – PRODUCTS

2.01 GEOTECHNICAL REPORT

A. See attached portions of geotechnical report, completed by Terracon, and dated February 6, 2015, project number EN145129.

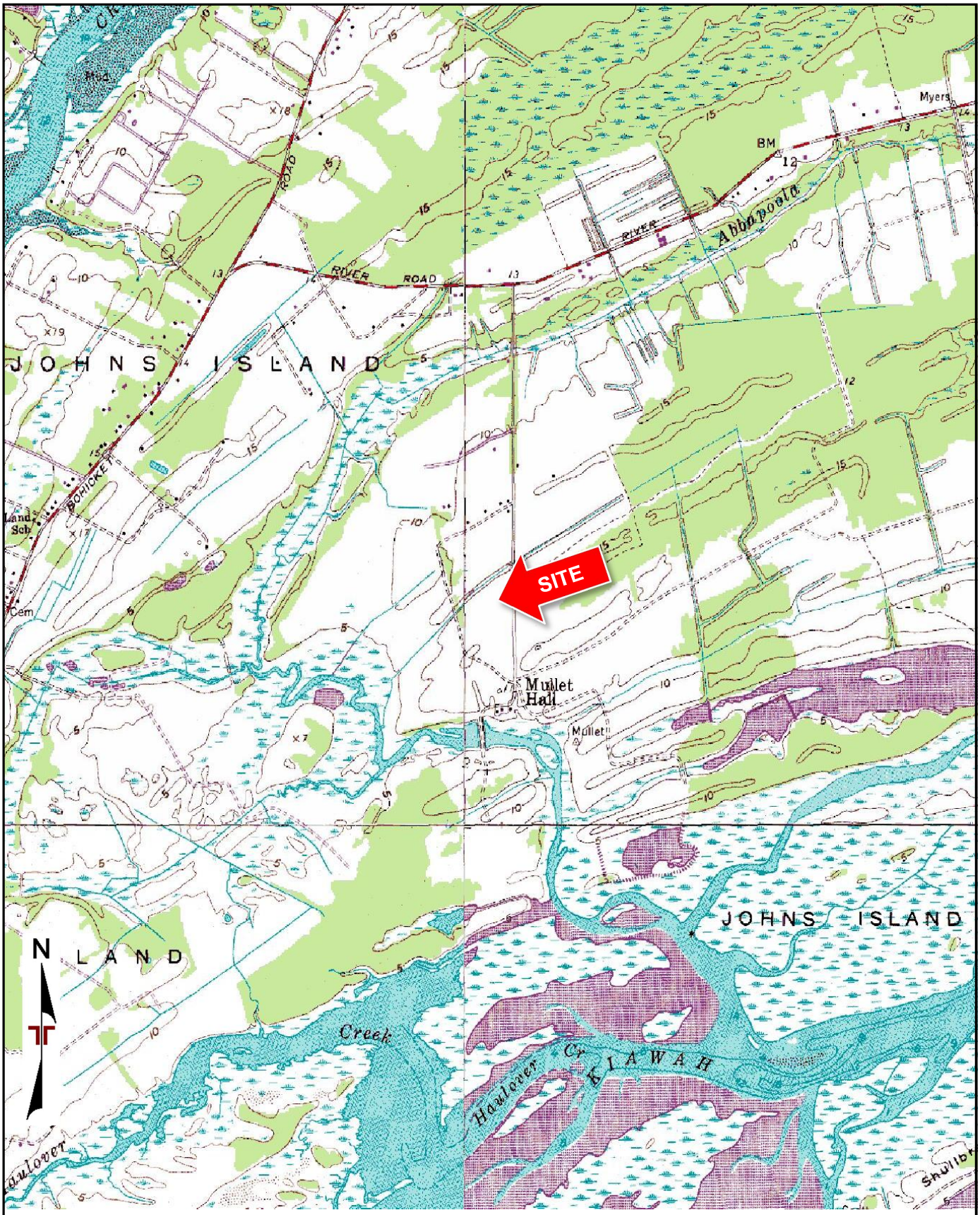
PART 3 – EXECUTION

None this Section.

END OF SECTION

APPENDIX A

Exhibit A-1 Site Location
ExhibitA-2ExplorationPlan
ExhibitA-3FieldExplorationDescription
ExhibitA-4InSituTestRecords
ExhibitA-5HandAugerBoring(HAB)Logs



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: WADMALAW ISLAND, SC (1/1/1971), LEGAREVILLE, SC (1/1/1971), ROCKVILLE, SC (1/1/1971) and KIAWAH ISLAND, SC (1/1/1971).

Project Manager:	ACL
Drawn by:	ACL
Checked by:	WBW
Approved by:	BTS

Project No.	EN145129
Scale:	1:24,000
File Name:	A-1
Date:	2/2/2015

Terracon
1450 5th St. West
North Charleston, SC 29405

SITE LOCATION

Johns Island WWTP
Mullet Hall Road
John's Island, SC

Exhibit

A-1

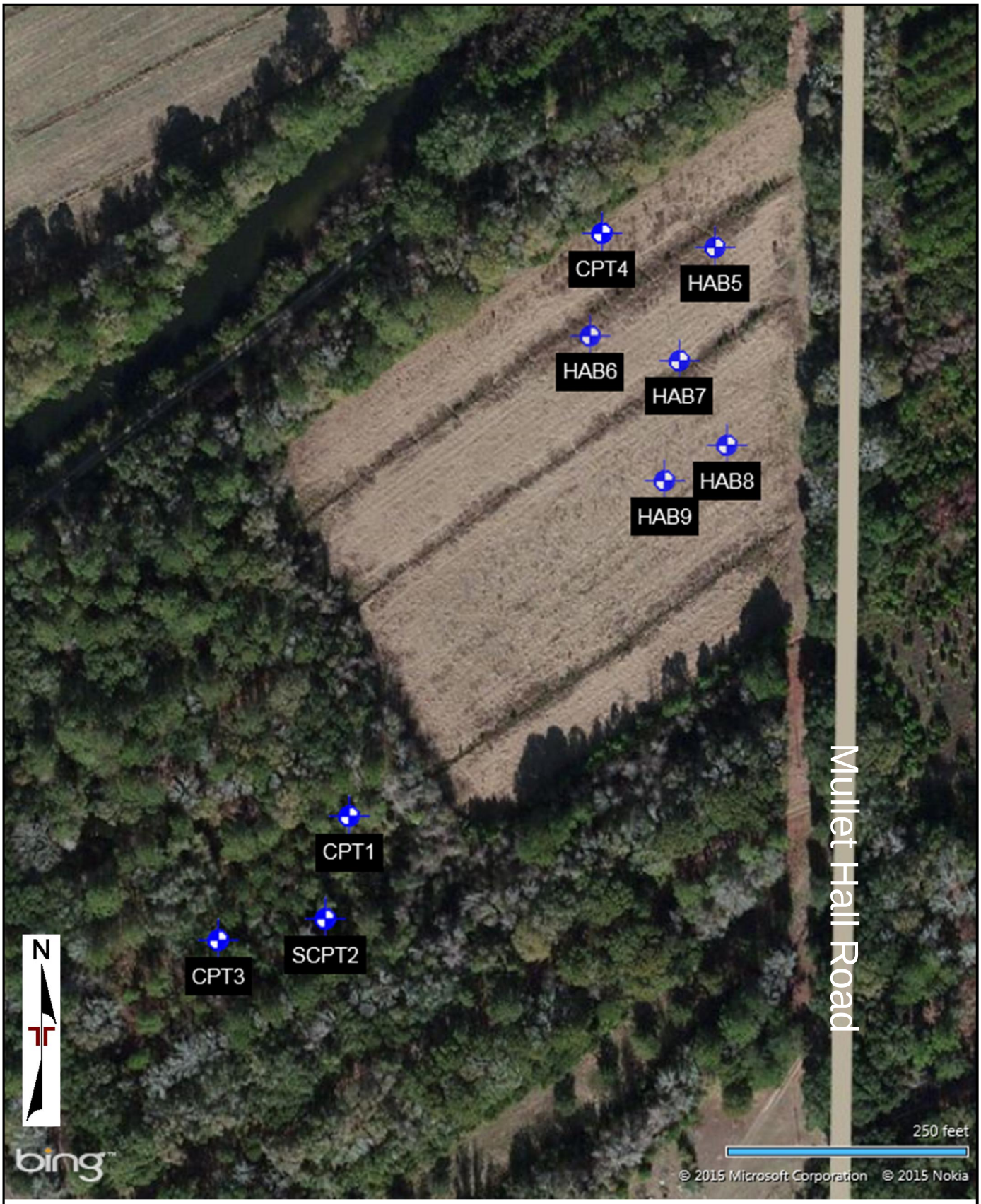


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager:	ACL
Drawn by:	ACL
Checked by:	WBW
Approved by:	BTS

Project No.	EN145129
Scale:	AS SHOWN
File Name:	A-2
Date:	2/2/2015

Terracon
1450 5th St. West
North Charleston, SC 29405

EXPLORATION PLAN

Johns Island WWTP
Mullet Hall Road
John's Island, SC

Exhibit

A-2

Field Exploration Description

The test locations were selected by Terracon personnel and located in the field utilizing a commercially available handheld Global Position System (GPS) unit. Dependent on the prevailing weather conditions at the time of boring/sounding layout and overhead power lines these units are typically considered accurate to within ±10 to 20 feet. The locations as shown in the exploration plan should be considered accurate only to the degree implied by the means and methods used to define them.

The in situ tests consisted of three Cone Penetration Tests (CPTs) to depths of 48 to 55 feet and one Seismic Cone Penetration Test (SCPT) to a depth of 60 feet. These tests were advanced with a track mounted Pagani 220-73 rig. Adjacent to each in situ test, we performed Hand Auger Borings (HABs) to depths of approximately 4 feet along with five HABs to depths of 4 feet at the proposed lagoon location.

The driller's logs were compiled and reviewed by the geotechnical engineer in order to produce the logs. The in situ tests and HAB logs are presented on Exhibits A-4 and A-5 in Appendix A. General notes and soil classification procedures for the in situ tests are presented on Exhibits B-1 and B-2 in Appendix B.

CPT LOG NO. CPT1

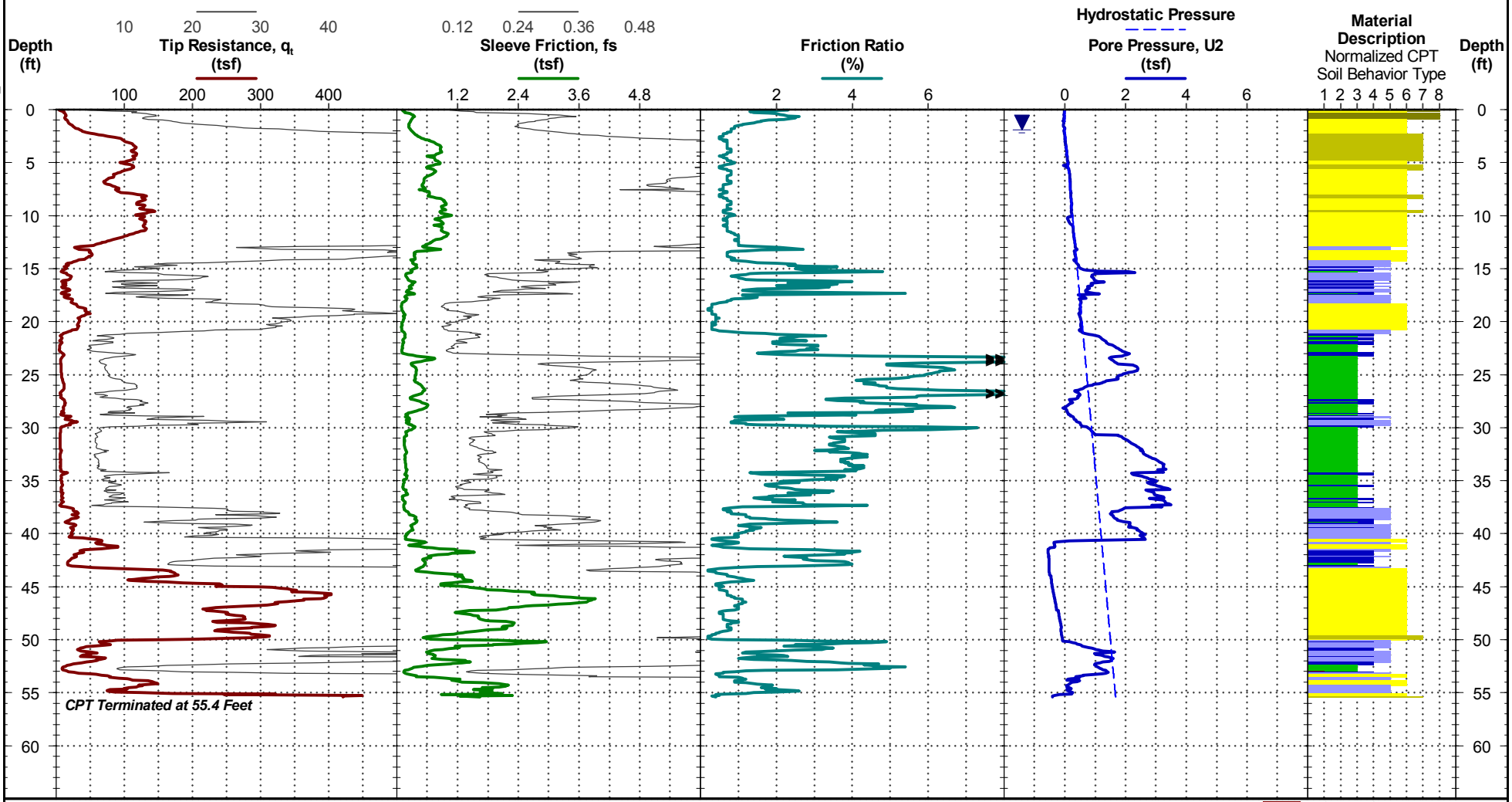
PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

TEST LOCATION: See Exhibit A-2

SITE: Johns Island, SC

Latitude: 32.63327°
Longitude: -80.12391°



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.

Dead weight of rig used as reaction force.
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION

▼ 1.9 ft estimated water depth
(used in normalizations and correlations; see Appendix B)

Probe no. 4526 with net area ratio of 0.83
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 11/12/2014
Tip and sleeve areas of 10 cm^2 and 150 cm^2
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 5th Street West
North Charleston, South Carolina

CPT Started: 1/13/2015	CPT Completed: 1/13/2015
Rig: Pagani TG73-200	Operator: BR
Project No.: EN145129	Exhibit: A-4

CPT LOG NO. SCPT2

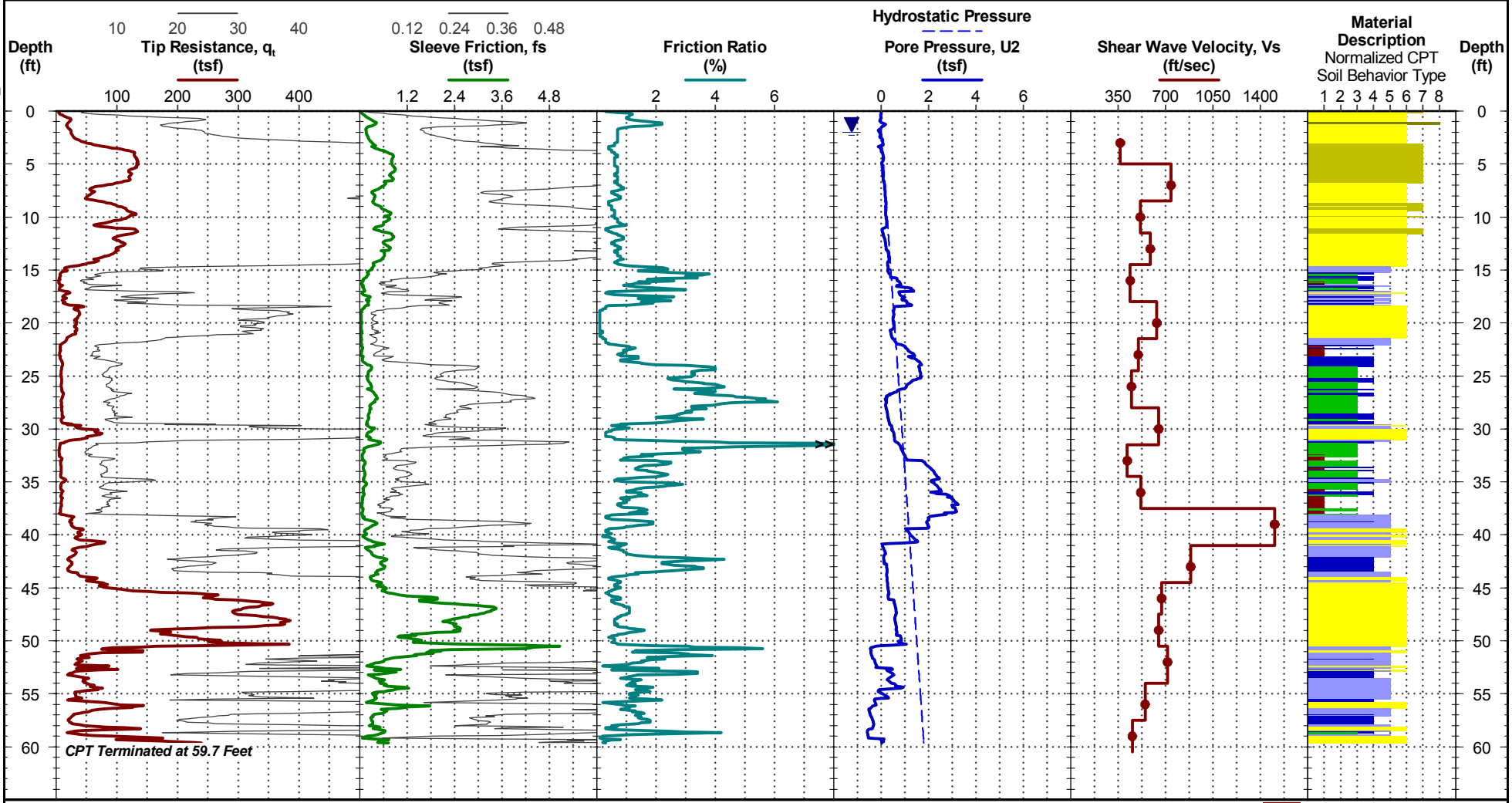
PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

TEST LOCATION: See Exhibit A-2

SITE: Johns Island, SC

Latitude: 32.63298°
Longitude: -80.12399°



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.

Dead weight of rig used as reaction force.
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION

▼ 2 ft measured water depth
(used in normalizations and correlations; see Appendix B)

Probe no. 4526 with net area ratio of 0.83
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 11/12/2014
Tip and sleeve areas of 10 cm^2 and 150 cm^2
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 5th Street West
North Charleston, South Carolina

CPT Started: 1/13/2015	CPT Completed: 1/13/2015
Rig: Pagani TG73-200	Operator: BR
Project No.: EN145129	Exhibit: A-4

CPT LOG NO. CPT3

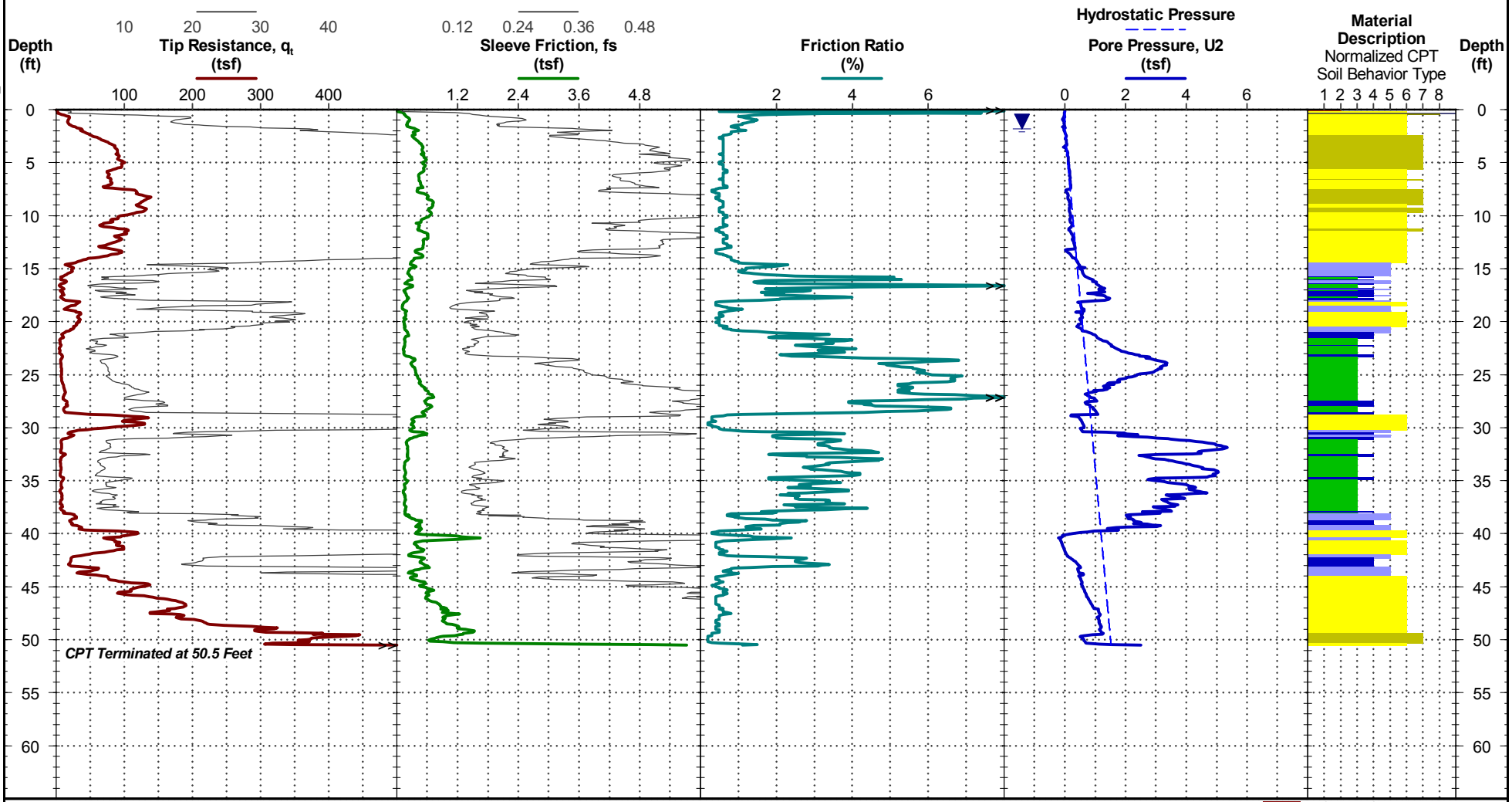
PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

TEST LOCATION: See Exhibit A-2

SITE: Johns Island, SC

Latitude: 32.63292°
Longitude: -80.12435°



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.

Dead weight of rig used as reaction force.
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION

▼ 1.8 ft measured water depth
(used in normalizations and correlations; see Appendix B)

Probe no. 4526 with net area ratio of 0.83
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 11/12/2014
Tip and sleeve areas of 10 cm^2 and 150 cm^2
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 5th Street West
North Charleston, South Carolina

CPT Started: 1/13/2015	CPT Completed: 1/13/2015
Rig: Pagani TG73-200	Operator: BR
Project No.: EN145129	Exhibit: A-4

CPT LOG NO. CPT4

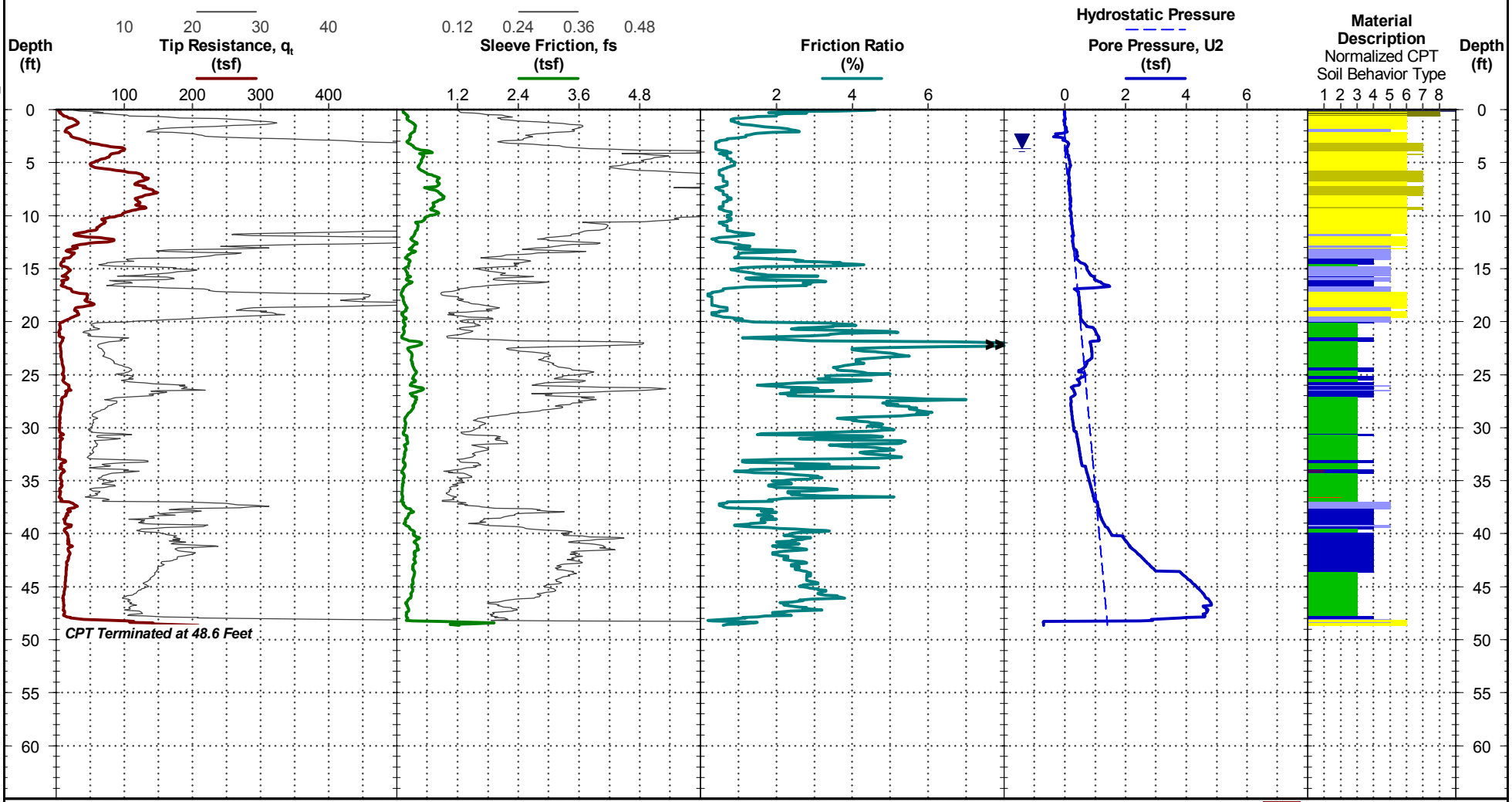
PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

TEST LOCATION: See Exhibit A-2

SITE: Johns Island, SC

Latitude: 32.63492°
Longitude: -80.12306°



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.

Dead weight of rig used as reaction force.
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION

▼ 3.7 ft measured water depth
(used in normalizations and correlations; see Appendix B)

Probe no. 4526 with net area ratio of 0.83
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 11/12/2014
Tip and sleeve areas of 10 cm^2 and 150 cm^2
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 5th Street West
North Charleston, South Carolina

CPT Started: 1/21/2015	CPT Completed: 1/21/2015
Rig: Pagani TG73-200	Operator: BR
Project No.: EN145129	Exhibit: A-4

BORING LOG NO. HAB at CPT1

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.63327° Longitude: -80.12391° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	TOPSOIL, 5" of Topsoil with roots 0.4			
	SILTY SAND (SM), reddish brown to pale brown, moist to wet 4.0		▽	
	Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 1.7 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/13/2015 | Boring Completed: 1/13/2015

Drill Rig: NA | Driller: BR

Project No.: EN145129 | Exhibit: A-5

BORING LOG NO. HAB at SCPT2

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

LOCATION See Exhibit A-2

Latitude: 32.63298° Longitude: -80.12399°

GRAPHIC LOG	DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	0.3	**TOPSOIL**, 4" of Topsoil with roots			
	4.0	**SILTY SAND (SM)**, dark gray and dark brown to pale brown, moist to wet		▽	
		Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 2.0 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/13/2015 Boring Completed: 1/13/2015

Drill Rig: NA Driller: BR

Project No.: EN145129 Exhibit: A-5

BORING LOG NO. HAB at CPT3

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.63292° Longitude: -80.12435° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	TOPSOIL, 5" of Topsoil with roots 0.4			
	SILTY SAND (SM), reddish brown to pale brown, moist to wet, with cemented sand from 10" to 15" 4.0		▽	
	Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 1.8 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/13/2015	Boring Completed: 1/13/2015
Drill Rig: NA	Driller: BR
Project No.: EN145129	Exhibit: A-5

BORING LOG NO. HAB at CPT4

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.63492° Longitude: -80.12306° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), dark brown to pale brown, moist to wet		▽	
	4.0 ***Boring Terminated at 4 Feet***			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 3.7 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/21/2015	Boring Completed: 1/21/2015
Drill Rig: NA	Driller: BR
Project No.: EN145129	Exhibit: A-5

BORING LOG NO. HAB5

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.63488° Longitude: -80.12268° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), dark brown to pale brown, moist to wet		▽	
	4.0 ***Boring Terminated at 4 Feet***			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 2.8 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/13/2015	Boring Completed: 1/13/2015
Drill Rig: NA	Driller: BR
Project No.: EN145129	Exhibit: A-5

BORING LOG NO. HAB6

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.63463° Longitude: -80.1231° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), pale brown to brown, moist to wet		▽	
	4.0 ***Boring Terminated at 4 Feet***			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 1.1 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/13/2015 | Boring Completed: 1/13/2015

Drill Rig: NA | Driller: BR

Project No.: EN145129 | Exhibit: A-5

BORING LOG NO. HAB7

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.63456° Longitude: -80.1228° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), dark brown to pale brown, moist to wet		▽	
	4.0 ***Boring Terminated at 4 Feet***			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 1.8 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/13/2015	Boring Completed: 1/13/2015
Drill Rig: NA	Driller: BR
Project No.: EN145129	Exhibit: A-5

BORING LOG NO. HAB8

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.63432° Longitude: -80.12264° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), dark brown to reddish brown and pale brown, moist to wet		▽	
	4.0 ***Boring Terminated at 4 Feet***			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 2.2 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/13/2015 | Boring Completed: 1/13/2015

Drill Rig: NA | Driller: BR

Project No.: EN145129 | Exhibit: A-5

BORING LOG NO. HAB9

PROJECT: Johns Island WWTP

CLIENT: Thomas & Hutton
Mount Pleasant

SITE:
Johns Island, SC

LOCATION See Exhibit A-2

Latitude: 32.63422° Longitude: -80.12285°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), dark brown to reddish brown and pale brown, moist to wet		▽	
	4.0			
	Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Manual Hand Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater encountered at 2.0 feet*

Terracon
1450 5th Street West
North Charleston, South Carolina

Boring Started: 1/13/2015 Boring Completed: 1/13/2015

Drill Rig: NA Driller: BR

Project No.: EN145129 Exhibit: A-5

APPENDIX B

Exhibit B-1 General Notes
Exhibit B-2 Unified Soil Classification System

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING


Auger


Split Spoon


Shelby Tube


Macro Core


Ring Sampler


Rock Core


Grab Sample


No Recovery

WATER LEVEL


Water Initially Encountered


Water Level After a Specified Period of Time


Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, tsf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 0.25	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	0.25 to 0.50	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	0.50 to 1.00	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	1.00 to 2.00	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	2.00 to 4.00	15 - 30	19 - 42
			Hard	> 4.00	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

CPT GENERAL NOTES

DESCRIPTION OF MEASUREMENTS AND CALIBRATIONS

To be reported per ASTM D5778:

Uncorrected Tip Resistance, q_c
Measured force acting on the cone divided by the cone's projected area

Corrected Tip Resistance, q_t
Cone resistance corrected for porewater and net area ratio effects
$q_t = q_c + U2(1 - a)$
Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, U1/U2
Pore pressure generated during penetration
U1 - sensor on the face of the cone
U2 - sensor on the shoulder (more common)

Sleeve Friction, fs
Frictional force acting on the sleeve divided by its surface area

Normalized Friction Ratio, FR
The ratio as a percentage of fs to q_t, accounting for overburden pressure

To be reported per ASTM D7400, if collected:

Shear Wave Velocity, Vs
Measured in a Seismic CPT and provides direct measure of soil stiffness

DESCRIPTION OF GEOTECHNICAL CORRELATIONS

Normalized Tip Resistance, Q_t
$Q_t = (q_t - \sigma_{v0})/\sigma'_{v0}$

Over Consolidation Ratio, OCR
$OCR\ (1) = 0.25(Q_t)^{1.25}$
$OCR\ (2) = 0.33(Q_t)$

Undrained Shear Strength, Su
$Su = Q_t \times \sigma'_{v0}/N_{kt}$
N_{kt} is a geographical factor (shown on Su plot)

Sensitivy, St
$St = (q_t - \sigma_{v0}/N_{kt}) \times (1/fs)$

Effective Friction Angle, ϕ'
$\phi'\ (1) = \tan^{-1}(0.373[\log(q_t/\sigma'_{v0}) + 0.29])$
$\phi'\ (2) = 17.6 + 11[\log(Q_t)]$

Unit Weight
$UW = (0.27[\log(FR)]+0.36[\log(q_t/atm)]+1.236) \times UW_{water}$
σ_{v0} is taken as the incremental sum of the unit weights

Small Strain Shear Modulus, G_0
$G_0\ (1) = \rho Vs^2$
$G_0\ (2) = 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$

Soil Behavior Type Index, Ic
$Ic = [(3.47 - \log(Q_t))^2 + (\log(FR) + 1.22)^2]^{0.5}$

SPT N_{60}
$N_{60} = (q_t/atm) / 10^{(1.1268 - 0.2817Ic)}$

Elastic Modulus, Es (assumes $q/q_{ultimate} \sim 0.3$, i.e. FS = 3)
$Es\ (1) = 2.6\Psi G_0$ where $\Psi = 0.56 - 0.33\log Q_{t,clean\ sand}$
$Es\ (2) = G_0$
$Es\ (3) = 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$
$Es\ (4) = 2.5q_t$

Constrained Modulus, M
$M = \alpha_M(q_t - \sigma_{v0})$
For Ic > 2.2 (fine-grained soils)
$\alpha_M = Q_t$ with maximum of 14
For Ic < 2.2 (coarse-grained soils)
$\alpha_M = 0.0188 \times 10^{(0.55Ic + 1.68)}$

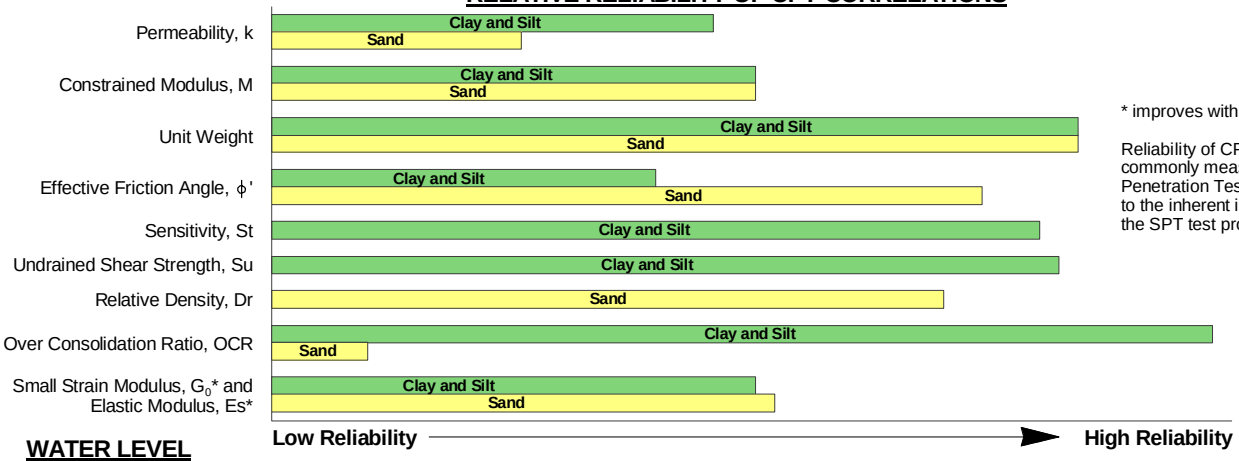
Hydraulic Conductivity, k
For $1.0 < Ic < 3.27$ $k = 10^{(0.952 - 3.04Ic)}$
For $3.27 < Ic < 4.0$ $k = 10^{(-4.52 - 1.37Ic)}$

Relative Density, Dr
$Dr = (Q_t / 350)^{0.5} \times 100$

REPORTED PARAMETERS

CPT logs as provided, at a minimum, report the data as required by ASTM D5778 and ASTM D7400 (if applicable). This minimum data include tip resistance, sleeve resistance, and porewater pressure. Other correlated parameters may also be provided. These other correlated parameters are interpretations of the measured data based upon published and reliable references, but they do not necessarily represent the actual values that would be derived from direct testing to determine the various parameters. The following chart illustrates estimates of reliability associated with correlated parameters based upon the literature referenced below.

RELATIVE RELIABILITY OF CPT CORRELATIONS



* improves with seismic Vs measurements

Reliability of CPT-predicted N_{60} values as commonly measured by the Standard Penetration Test (SPT) is not provided due to the inherent inaccuracy associated with the SPT test procedure.

WATER LEVEL

The groundwater level at the CPT location is used to normalize the measurements for vertical overburden pressures and as a result influences the normalized soil behavior type classification and correlated soil parameters. The water level may either be "measured" or "estimated:"

Measured - Depth to water directly measured in the field

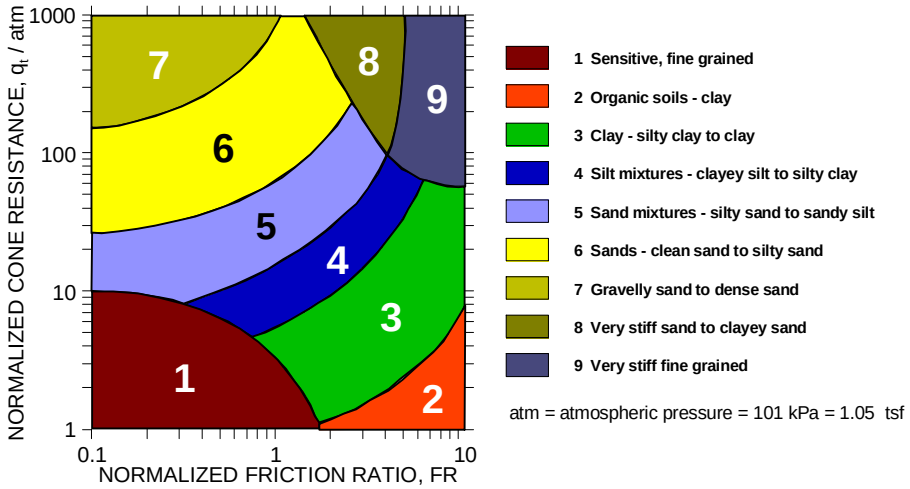
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions

While groundwater levels displayed as "measured" more accurately represent site conditions at the time of testing than those "estimated," in either case the groundwater should be further defined prior to construction as groundwater level variations will occur over time.

CONE PENETRATION SOIL BEHAVIOR TYPE

The estimated stratigraphic profiles included in the CPT logs are based on relationships between corrected tip resistance (q_t), friction resistance (fs), and porewater pressure (U2). The normalized friction ratio (FR) is used to classify the soil behavior type.

Typically, silts and clays have high FR values and generate large excess penetration porewater pressures; sands have lower FRs and do not generate excess penetration porewater pressures. Negative pore pressure measurements are indicative of fissured fine-grained material. The adjacent graph (Robertson et al.) presents the soil behavior type correlation used for the logs. This normalized SBT chart, generally considered the most reliable, does not use pore pressure to determine SBT due to its lack of repeatability in onshore CPTs.



atm = atmospheric pressure = 101 kPa = 1.05 tsf

REFERENCES

Kulhawy, F.H., Mayne, P.W., (1997). "Manual on Estimating Soil Properties for Foundation Design," Electric Power Research Institute, Palo Alto, CA.

Mayne, P.W., (2013). "Geotechnical Site Exploration in the Year 2013," Georgia Institue of Technology, Atlanta, GA.

Robertson, P.K., Cabal, K.L. (2012). "Guide to Cone Penetration Testing for Geotechnical Engineering," Signal Hill, CA.

Schmertmann, J.H., (1970). "Static Cone to Compute Static Settlement over Sand," *Journal of the Soil Mechanics and Foundations Division*, 96(SM3), 1011-1043.

Terracon

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

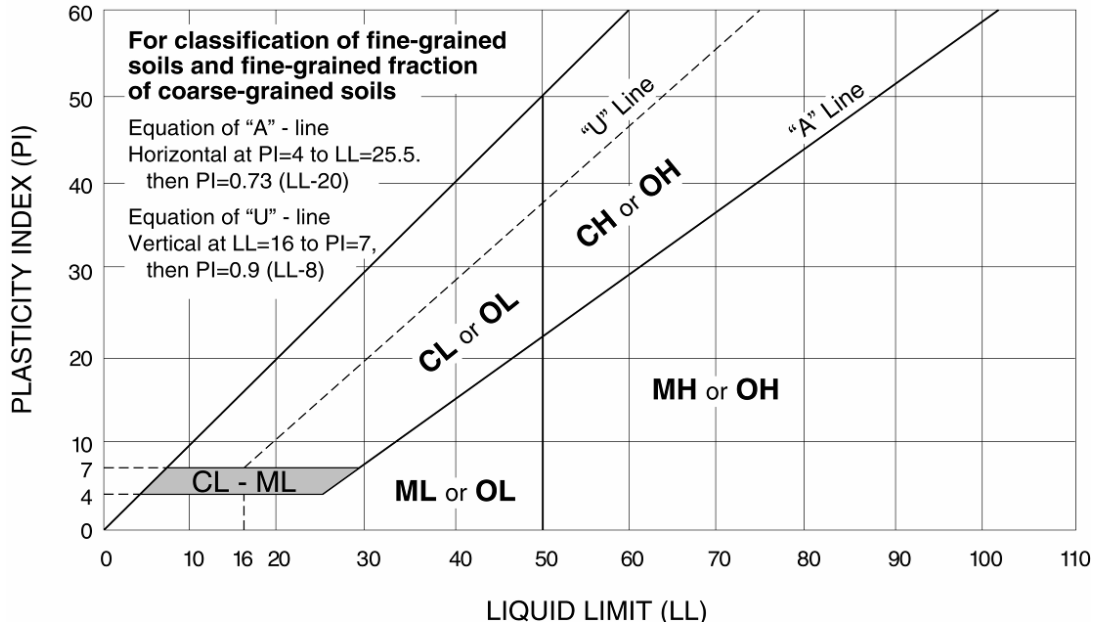
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



INDEX TO

SECTION 02 41 13

SELECTIVE SITE DEMOLITION

SECTION 02 41 13

SELECTIVE SITE DEMOLITION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of selective demolition work is indicated on drawings.

B. Adhere to all SCDHEC (South Carolina Department of Health and Environmental Control) standards and requirements.

1.03 SUBMITTALS

A. Schedule: Submit schedule indicating proposed methods and sequence of operations for selective demolition work to Owner's representative for review prior to commencement of work. Include coordination for shut–off, capping, and continuation of utility services as required, together with details for dust and noise control protection. Include schedule and location for return of any items identified on plans that are to be delivered to Owner.

1.04 JOB CONDITIONS

A. Condition of Structures: Owner assumes no responsibility for actual condition of items to be demolished.

B. Partial Demolition and Removal: Items designated for removal shall be removed as work progresses. Transport salvaged items from site as they are removed. Storage or sale of removed items on site shall not be permitted.

C. Protections: Provide temporary barricades and other forms of protection as required to protect Owner's personnel and general public from injury due to selective demolition work.

D. Protect all existing structures that are designated to remain throughout demolition operations. Remove protections at completion of work.

1.05 DAMAGES

A. Promptly repair damages caused to adjacent facilities by demolition work at no cost to Owner.

1.06 TRAFFIC

A. Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

B. Do not close, block or otherwise obstruct streets, walks, or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways.

1.07 EXPLOSIVES

A. Use of explosives will not be permitted.

1.08 UTILITY SERVICES

A. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.

B. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

1.09 ENVIRONMENTAL CONTROLS

A. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.

B. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

1.10 MEASUREMENT AND PAYMENT

A. There will be no measurement for selective demolition. Payment will be made at the contract lump sum price. Payment will include equipment, labor, materials, protection, clean–up, disposal, and all work necessary to complete the selective demolition shown on the construction drawings.

PART 2 – PRODUCTS

None in this section

PART 3 – EXECUTION

3.01 PREPARATION

A. Prior to commencement of selective demolition work, check areas in which work will be performed. Photograph or video existing conditions of surfaces, equipment, or surrounding properties that could be misconstrued as damage resulting from

selective demolition work. Review items of concern onsite with Owner. File with Owner or Owner's Representative prior to starting work.

B. Cover and protect equipment and fixtures to remain from soiling or damage when demolition work is performed in areas from which such items have not been removed.

3.02 DEMOLITION

A. Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on drawings in accordance with demolition schedule and governing regulations.

B. Demolish concrete in small sections. Cut concrete at junctures with construction to remain using power–driven masonry saw or hand tools. Do not use power–driven impact tools.

C. Completely fill below–grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel and sand, free of trash and debris, stones over two-inch diameter, roots, or other organic matter.

D. If unanticipated mechanical, electrical, or structural elements, which conflict with intended function or design, are encountered, investigate and measure both nature and extent of the conflict. Submit report to Owner in written, accurate detail. Pending receipt of directive from Owner, rearrange selective demolition schedule as necessary to continue overall job progress without delay.

3.03 SALVAGE MATERIALS

A. All equipment and materials desired by Owner shall be delivered to a designated location, not further than two miles from the job site. Desired equipment may include, but not be limited to, generator, transfer switch, pumps, motors, controls, valves, electrical panels, and other items.

B. Any articles of historic significance will remain the property of the Owner. Notify Owner immediately if such items are encountered. Stop demolition orexcavation work and obtain acceptance regarding further historical investigation, method of removal or salvage for Owner.

3.04 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove debris, rubbish and other materials resulting from demolition operations from site. Transport and legally dispose of materials off site.

B. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.

C. Burning of removed materials is not permitted on project site.

3.05 CLEAN–UP AND REPAIR

A. Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protections and leave site clean.

B. Repair demolition performed in excess of required work. Return structures and surfaces to remain to the condition existing prior to commencement of selective demolition work. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

C. Fill in all voids created by selective demolition and grade site to drain. Grass all disturbed areas for erosion control.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Cast-in-place concrete for basin slab, walls, beams, slab on grade of building, equipment slabs, dumpster pad, wash pad, and stair slabs.

B. Formwork, form accessories, and bracing.

C. Reinforcement.

D. Joint Materials.

E. Waterstops.

1.2 RELATED SECTIONS

A. Section 02 30 00 – Subsurface Investigation

B. Section 31 00 00 – Earthwork

C. Section 31 23 13 – Subgrade Preparation

1.3 REFERENCES (LATEST REVISION)

A. Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice.

B. CRSI Placing Reinforcing Bars

C. AASHTO M 182 – Burlap Cloth Made from Jute or Kenaf

D. ACI 211.1 – Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

E. ACI 301 – Specifications for Structural Concrete.

F. ACI 302.1R – Guide for Concrete Floor and Slab Construction.

G. ACI 304R – Guide for Measuring, Mixing, Transporting and Placing Concrete.

H. ACI 305R – Hot Weather Concreting.

I. ACI 306R – Cold Weather Concreting.

J. ACI 308R – Guide to Curing Concrete.

K. ACI 318 – Building Code Requirements for Structural Concrete.

L. ACI 347 – Guide to Formwork for Concrete.

M. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary

N. ACI 350.1 – Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary

O. ASTM A185 – Steel Welded Wire Reinforcement, Plain, for Concrete

P. ASTM A615 – Deformed and Plain Carbon – Steel Bars for Concrete Reinforcement.

Q. ASTM C 31 - Making and Curing Concrete Test Specimens in the Field

R. ASTM C 33 – Concrete Aggregates.

S. ASTM C 39 – Compressive Strength of Cylindrical Concrete Specimens.

T. ASTM C 42 – Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

U. ASTM C 94 – Ready-Mixed Concrete.

V. ASTM C 143 - Slump of Hydraulic Cement Concrete

W. ASTM C 150 – Portland Cement.

X. ASTM C 171 - Sheet Materials for Curing Concrete

Y. ASTM C 172 – Practice for Sampling Freshly Mixed Concrete.

Z. ASTM C 231 – Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

AA. ASTM C 260 – Air-Entraining Admixtures for Concrete.

BB. ASTM C 309 – Liquid Membrane-Forming Compounds for Curing Concrete.

CC. ASTM C 494 – Chemical Admixtures for Concrete.

DD. ASTM C 618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

EE. ASTM C 920 – Standard Specification for Elastomeric Joint Sealants

FF. ASTM C 989 – Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

GG. ASTM C 1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

HH. ASTM D 1751 – Preformed Expansion Joint Filler for Concrete paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

II. ASTM D 2103 – Polyethylene Film and Sheeting

JJ. ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

KK. ASTM E 329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

LL. ASTM E 1155 - Determining Floor Flatness and Floor Levelness Numbers

1.4 MEASUREMENT AND PAYMENT

Under this contract concrete items will be covered in the Contractor's bid as a lump sum amount. The cost for concrete items will include all materials, accessories, testing and labor required to satisfy the requirements of this specification and the designs provided on the construction drawings.

1.5 SUBMITTALS FOR REVIEW

The Engineer of Record will review the submittals identified herein.

A. Product Data: Provide data for proprietary materials and items, including reinforcements, admixtures, forming accessories, curing compounds and others if requested by Engineer.

B. Mix designs and test results as specified hereinafter.

C. Shop Drawings: Submit shop drawings for fabrication, bending and placement of reinforcing steel to Engineer for review. Comply with ACI 315 "Manual of Standard Practice for Detailing Concrete Reinforced Structures". Indicate sizes, spacing, and locations of reinforcing steel, supporting and spacing devices, bar bending details, and bar lists.

D. Water Test Program, further detailed herein.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301, 318 and 350, as applicable. ACI 350 requirements shall be applied to the Basins (water containing structures) and Chlorine Contact Basin, and Primary Influent Screen slab.

B. Maintain at least one copy of ACI 301 document on site at all times.

C. Acquire cement and aggregate from same source for all work.

D. Conform to ACI 305R when concreting during hot weather.

E. Conform to ACI 306R when concreting during cold weather.

F. Conform to ACI 117 –Specifications for Tolerances for Concrete Construction and Materials.

G. Engineer reserves the right to mark and reject portions of concrete not within tolerance as specified.

H. Concrete Mix Design: Employ a testing laboratory acceptable to the Engineer to perform material evaluating tests and to design concrete mixes. Concrete mix design shall be at Contractor's expense. Submit mix designs to Engineer at least 25 days prior to start of work.

I. Materials and installed work may require testing and retesting at any time during process of work, and shall be done at Contractor's expense.

J. Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades (as applicable) or shall have written evidence of having completed similar qualification programs:

1. Concrete Field Testing Technician, Grade I
2. Concrete Laboratory Testing Technician, Grade I or II
3. Concrete Construction Inspector, Level II
4. Concrete Transportation Construction Inspector or
5. Reinforced Concrete Special Inspector, Jointly certified by American Concrete Institute (ACI) and International Code Council (ICC) and licensed by South Carolina Department of Labor, Licensing and Regulations (SCLLR).

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation

1.7 TESTS

A. All sampling and testing services shall be performed by a testing agency which operates in accordance to ASTM D 3740 and E 329 latest revision and acceptable to the Engineer, as part of the special inspections, at Owner's expense. Contractor shall conduct all coordination and scheduling with testing and inspection agency. Owner shall not pay for testing agency services if, due to Contractor's schedule mishaps or lack of preparedness, testing and inspecting services are scheduled and not required.

B. Contractor shall submit to the Engineer, concrete materials and concrete mix designs of concrete proposed for use. This submittal shall include results of all testing performed to qualify materials and establish mix designs. All mix designs shall be proportioned in accordance with Section 3.9 of ACI 301, Method 1 (trial batches) or Method 2 (field experience). The average strength used as basis for selecting proportions shall be as specified in Paragraph 3.9.2 of ACI 301.

C. Testing laboratory shall conduct strength tests of the concrete during construction in accordance with Section 16.3.4 of ACI 301. At least one strength test (6 test cylinders) shall be made for each 50 cubic yards or fraction thereof, of each mix design placed each day.

D. Slump tests shall be conducted regularly during construction in accordance with Section 16.3.5 of ACI 301.

E. Air content of the concrete sample for each strength test shall be determined in accordance with Section 16.3.6 of ACI 301.

F. Density (unit weight) of concrete shall be determined for each sample, in accordance with ASTM C138.

G. Results of all tests shall be submitted to Engineer within three days of testing, with copies to Contractor. Test reports shall include the exact location in the work at which batch represented by a test was deposited.

H. Evaluation of test results and acceptance of concrete shall be in accordance with Chapter 17 of ACI 301.

I. Floor flatness and levelness shall be as specified herein. All floor tolerance measurements shall be made within 48 hours of slab installation and shall precede the removal of forms. The results of all floor profile tests shall be provided to the Engineer within 72 hours after each slab installation.

J. Water Tightness Test shall be conducted in accordance with ACI 350.1 and as specified herein.

1.8 ACCEPTANCE OF COMPLETED WORK:

A. Acceptance or rejection of completed concrete work shall be in accordance with Chapter 18 of ACI 301.

PART 2 – PRODUCTS

2.1 FORM MATERIALS

A. Shall conform to ACI 301.

B. All form materials shall be selected to provide desired finish, prevent any deflection at any point in time and spalling during form removal.

C. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings.

D. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material.

E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with or adversely affect concrete surfaces.

F. Form Ties: factory fabricated, adjustable length, removable or snap-off type, galvanized metal form ties with cones. Ties shall be free of defects and shall not

leave holes larger than 1-inch in concrete surface upon removal. Provide units that will leave metal no closer than 1½ inches to surface.

G. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.

H. Chamfered Corners: Chamfered strip type; ¾"x¾" typically; maximum possible lengths.

I. Dovetail Anchor Slot: Galvanized steel, 22 gage thick, foam filled slots, nail holes for securing to concrete formwork; Heckman Building Products No. 100 or as approved.

J. Flashing Reglets: Galvanized steel, 26 gage thick, longest possible lengths, with alignment splines for joints, tape sealed slots, anchors for securing to concrete formwork, sloped strip-out, Heckman Building Products No. 230 or as approved.

2.2 REINFORCING MATERIALS

A. Reinforcing Steel: ASTM A 615, Grade 60 billet steel deformed bars; uncoated finish.

B. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting, and fastening reinforcing bars in place. Use wire bar type supports complying with CRSI specifications.

1. For concrete cast on grade, use supports with sand plates or horizontal runners where base material will not support chair legs or 6,000 psi solid concrete blocks meeting CRSI requirements.
2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.3 CONCRETE MATERIALS

A. Cement: ASTM C 150, Type I – Normal. Use one (1) brand of cement throughout the project.

B. Fine and Coarse Aggregates: ASTM C 33. Coarse aggregate shall be No. 57 (up to 1"). Provide aggregate from a single source. All aggregate shall be washed, free from dirt and debris and shall be uniformly graded.

C. Water: Clean, fresh and not detrimental to concrete, ASTM C 94.

D. Fly Ash: ASTM C 618 Type F. Loss of ignition shall not exceed 3%. Amount of fly ash not to exceed 25% by weight of total cementitious material.

E. Ground Granulated Blast Furnace Slag: ASTM C 989. Amount of slag not to exceed 45% by weight of total cementitious material.

2.4 ADMIXTURES

A. Air Entrainment: ASTM C 260. Certified by manufacturer to be compatible with other required admixtures. Use air-entraining admixture in concrete for all structural concrete exposed to the weather. Do not use for interior building slabs. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of that specified in concrete mix requirements stated below.

B. Chemical: ASTM C 494. Types A-G, containing not more than 0.1 percent chloride ions. A high range water reducer (HRWR) is required for all concrete in walls and for other concrete which is pumped. It is optional for other concrete which is not pumped.

C. Pozzolanic Admixtures: ASTM C 618.

D. Calcium chloride or admixtures containing more than 0.1% chloride ions are <u>not</u> permitted.

E. Certification: Written certification of conformance to above-mentioned requirements and the chloride ion content will be required from admixture manufacturer prior to mix design review by Engineer.

2.5 ACCESSORIES

A. Bonding Compound: Polyvinyl acetate, rewettable type; by the Sika Corporation or equivalent.

B. Epoxy Adhesive: Two component, 100% solids, 100% reactive compound suitable for use on dry or damp surfaces; Sikadur by Sika Corporation or equivalent.

C. Non-Shrink Grout: ASTM C 1107, Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 6,000 psi in 28 days.

D. Concrete Repair Grout: For the repair of defective areas of concrete.

1. For vertical and overhead surfaces, use one (1) of the following (or approved equal):
   a. “Five Star Structural Concrete V/O"; Five Star Products, Inc.
   b. “Euco Verticoat"; Euclid Chemical Co.
   c. “Sikatop 122"; Sika Corp.

2. For horizontal surfaces, use one (1) of the following (or approved equal):
   a. "Five Star Structural Concrete"; Five Star Products, Inc.
   b. "Concrete Coat"; Euclid Chemical Co.
   c. "Sikatop 122"; Sika Corp.

E. Concrete Slab on Grade Crack Repair: Cracks up to ¼” wide are to be filled with Spal-Pro 2000 by Metzger/McGuire or approved equal.

F. Structural Slab & Wall Crack Repair: Cracks up to 1/8” wide are to be filled with Prime Flex 900 XLV by Prime Resins or approved equal.

G. Joint Filler (to be applied at joints between vertical edges where noted on drawings): Preformed, Nonextruding, Resilient, Bituminous; ½"-1" joint width; ASTM D1751. Size of filler shall be determined in accordance with typical joint detail provided on Structural Drawings.

H. Joint Sealant (to be applied at joints between vertical edges where noted on drawings): Elastomeric sealant, ASTM C920, single component (Type S), pourable or non-sag grade (Grade P or NS), class 50 or 100/50, use T; ½"-1" joint width.

I. Waterstops: All waterstops shall be PVC Flat Ribbed profile, fabricated and installed per manufacturer's recommendations. Waterstops shall be provided at all joints in the water containing basins unless noted otherwise. Waterstops are not required at joints occurring above elevation 26.0.

1. All waterstops shall be 6" wide by 3/8" thick Greenstreak style number 679 or equal, except where noted otherwise.

2. Where 4" waterstop is required, a 4" wide by 3/16" thick Greenstreak style number 781 or equal shall be used.

J. Vapor Barrier: 10 mil polyethylene sheeting shall be provided underneath the concrete slab on grade of the building. Vapor barrier shall be in accordance with ASTM D 2103.

2.6 CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171:

1. Waterproof paper
2. Polyethylene film
3. Polyethylene-coated burlap

C. Membrane Curing Compound: ASTM C 309, clear with fugitive dye, 30% solids.

2.7 CONCRETE MIX DESIGN

The following shall apply to all concrete shown on the structural drawings:

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch (with 3 point curve) or field experience methods as specified in ACI 301. If trial batch method is used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs.

B. Submit written reports to Structural Engineer of proposed mix for concrete at least 25 days prior to start of work. Do not begin concrete production until mixes have been approved by Engineer.

C. Concrete shall be batched, mixed and transported from a supplier with sufficient facilities to deliver concrete at the rate required and in accordance with ASTM C

94. Ready-mix concrete supplier shall furnish Engineer a certified statement the concrete furnished conforms to provisions of these specifications.

D. Compressive Strength: Minimum 4,000 psi in 28 days.

E. Water/cement ratio (maximum): 0.5 by weight.

F. Slump: 4 to 5 inches maximum, measured at the point of discharge, before the addition of any high range water reducer (HRWR). If HRWR is added at the concrete plant, then slump may be measured at the job site after the HRWR has been added.

G. Air Entrainment: 3.5% ± 1%.

H. Fly Ash Content: 15-25% of total cementitious material

I. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

2.8 CONCRETE MIXING

A. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

B. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.

1. When air temperature is between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C), reduce mixing and delivery time from 90 minutes to 75 minutes, and when air temperature is above 90 degrees F (32 degrees C), reduce mixing and delivery time to 60 minutes. Concrete shall not be placed when the air temperature exceeds 95 degrees.

PART 3 – EXECUTION

3.1 ON SITE OBSERVATIONS OF WORK

A. Coordination: Coordinate the installation of joint materials with placement of forms and reinforcing steel. Coordinate opening sizes and locations, as well as reinforcing around the openings, with the architectural, mechanical, electrical and plumbing drawings.

B. Engineer or Project Representative will have the right to require any portion of work be completed in their presence and if work is covered up after such instruction, it shall be exposed by Contractor for observation. However, if Contractor notifies Engineer such work is scheduled, and the Engineer fails to appear within 48 hours, Contractor may proceed.

C. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. Improper work shall be reconstructed. All materials, which do not conform to requirements of specifications, shall be removed from work upon notice being received from the Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

D. Contractor shall give the Project Engineer or Project Representative and Special Inspector a minimum of 48 hours notice for all required observations or tests.

E. Special Inspector shall inspect forms and reinforcing within 24 hours prior to concrete pours. Engineer shall have the option to inspect forms and reinforcing within 24 hours prior to concrete pours. It is Contractor's responsibility to notify Special Inspector Engineer as required herein.

3.2 FORMWORK PREPARATION & ERECTION

A. Design of formwork is Contractor's responsibility. Erect formwork, shoring, and bracing to support vertical, lateral, static and dynamic loads until such loads can be supported by concrete structure in accordance with requirements of ACI 301. Maintain formwork construction tolerances complying with ACI 347.

B. Forms shall conform to shapes, lines, elevations, locations and dimensions of members as called for on the plans. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes.

C. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.

D. Earth forms shall not be permitted for the installation of structural concrete.

E. Contractor shall coordinate the work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

F. Before placing of either reinforcing steel, embedded items, or concrete, surfaces of forms shall be thoroughly cleaned and covered with an accepted coating material which will effectively prevent absorption of moisture and prevent bond with the concrete. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

G. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

H. Chamfer all exposed corners and edges ¾" unless noted otherwise, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

I. Fabricate forms for easy removal without hammering or prying against concrete surfaces.

J. During cold weather remove ice and snow from within the forms. Do not use de-icing salts. Do not use water to clean out forms unless formwork and concrete construction proceed within heated enclosed areas.

3.3 FORM REMOVAL

A. Forms shall be removed carefully to avoid damage to green concrete. Ties shall be cut back 1 inch from the surface and all holes, stone pockets, voids, and minor defects shall be patched immediately upon removal of forms.

B. Forms shall not be removed within 7 days of pouring concrete, unless 70% of compressive strength has been achieved AND Engineer has approved removal.

C. Contractor shall keep live loads off the concrete until it has sufficient strength to support applied loads.

B. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

C. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

D. Store removed forms so surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

3.4 REINFORCEMENT

A. All reinforcement shall be free of rust, mill scale, ice, mud, oil or other materials which may adversely affect or reduce the bond.

B. Reinforcement shall be placed, supported, and secured against displacement by construction loads or the placing of concrete. Bar supports and spacers shall be made of concrete, metal, plastic, or other accepted material and subject to review by the Engineer. Where concrete surfaces will be exposed to weather in the finished structure, portions of all accessories within 1/2 inch of surface shall be noncorrosive or protected against corrosion.

C. Reinforcement shall be placed in accordance with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars". Minimum concrete cover for reinforcement shall be as required in ACI 318 and 350, as applicable.

D. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement and operations. Set wire tires so ends are directed in to concrete, not toward exposed concrete surfaces. As a minimum, tie alternate bar intersections.

E. Field bending of bars partially imbedded in concrete will not be permitted.

F. Locate reinforcing splices not indicated on the drawings at points of minimum stress.

G. Accommodate placement of formed openings. Provide additional reinforcing as required.

3.5 PREPARATION FOR PLACING

A. Water shall be removed from excavations before concrete is deposited. Hardened concrete debris and other foreign materials shall be removed from the interior of forms and inside of mixing and conveying equipment.

B. Care shall be taken in the placement of the vapor barrier. Sheeting shall not be punctured or otherwise damaged in such a way that compromises the functionality of the vapor barrier.

C. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

D. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

E. Templates shall be used for the proper installation of anchor bolts. Templates and anchor bolts shall be in position prior to placing the concrete.

F. Waterstop shall be placed where shown on the construction drawings and specified herein, in accordance with instructions and products supplied by the manufacturer. Placement within the form and amount of concrete coverage shall be as required by manufacturer. Waterstop shall be held in place by acceptable measures so there will be no lateral movement or bending of the material during placement of concrete.

G. Construction Joints: Locate construction joints so as not to impair strength and appearance of the structure, as acceptable to Engineer. Where specified, provide construction joint layout plans for Engineers' approval.

H. Continue reinforcement across construction joints.

I. Isolation/Expansion Joints: Construct isolation joints between structural concrete and site concrete & pavement, as indicated on the plans. Materials for isolation/expansion joints are to be as specified previously in this specification.

3.6 PLACING CONCRETE

A. Place concrete in accordance with ACI 301, 304, 318, and 350, as applicable.

B. Pre-placement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Notify Engineer minimum 48 hours prior to commencement of placement.

C. Moisten wood forms immediately before placing concrete where form coatings are not used.

D. Concrete shall be placed only upon surfaces free from frost, ice, mud, standing water and other detrimental substances or conditions.

E. Concrete shall be handled and deposited using equipment and methods which will prevent segregation or loss of ingredients. Equipment and methods for placing concrete shall be subject to review by the Engineer.

F. Water shall not be added at the site without permission from the Engineer.

G. Concrete having attained its initial set or having contained water for more than 90 minutes shall not be used in the work.

H. Sufficient mixing and placing capacity shall be provided so concrete which is being integrated with fresh concrete is still plastic. Concrete shall be deposited continuously or in layers of such thickness so no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be placed subject to acceptance by the Engineer.

I. Concrete shall not be allowed or caused to flow horizontally or on slopes in the forms. Concrete placing on a slope shall begin at lower end of the slope and progress upward.

J. Consolidate by mechanical vibration so concrete is thoroughly worked around the reinforcement, around embedded items and into corners of forms and around piling. Use of vibrators to transport concrete within forms shall not be allowed. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

K. A spare vibrator shall be kept on the job site during all concrete placing operations.

L. When temperature of the surrounding air is expected to be below 40 degrees F during placing or 24 hours thereafter, temperature of concrete as placed, shall be no lower than 55 degrees for sections less than 12 inches in any dimension nor 50 degrees for any other sections. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set or cold joints and shall not exceed 95 degrees F.

M. Ensure reinforcement, inserts, embedded parts, and shear studs are not disturbed during concrete placement.

N. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

O. Place Concrete continuously in designated section. Do not interrupt successive placement or permit cold joints to occur.

P. Separate slabs on grade from vertical surfaces with joint filler, as specified on the construction drawings.

Q. Place joint filler securely to resist movement by wet concrete. Set top to required elevation to accommodate joint sealant.

R. Saw cut control joints (where indicated and as specified on drawings) within 8 hours of hardening.

3.7 CONCRETE FINISHING

A. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

B. Interior Floor Flatness Tolerance for Building Slab on Grade: A nonslip conventional flatness requirement of F_F/F_L = 15/15, SWI = 5mm, is applicable to interior slab surfaces. Testing shall be accordance with ASTM E 1155.

C. Formed surfaces of concrete shall be given finishes specified below unless the contract documents specify otherwise.

1. Rough Form Finish – For all concrete surfaces not exposed to public view. No selected form facing materials shall be specified for rough form finish surfaces. Tie holes and defects shall be patched. Fins exceeding 1/4 inch in height shall be chipped or rubbed off. Otherwise, surfaces shall be left with texture imparted by the forms.

2. Rubbed Form Finish: For sides of formed concrete surfaces exposed-to-view. This includes walls, slabs, & beams extending to one (1) foot below grade. Use smooth, high quality forms. Chip away all high spots. Within 72 hours after forms are removed, fill all air bubbles and small holes with a sand-cement-bonding agent grout proportional to match the surrounding finish. Rub the entire surface of with a fine abrasive stone to create a smooth surface, free of all form marks and holes. Do <u>not</u> finish by leaving a thin "plastered" layer of grout. For repair of defective areas with holes deeper than 1/2", refer to concrete repair products listed in section 2 of this specification.

3. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

4. Float Finish: Provide a float finish to 2nd level floor slabs except where noted otherwise herein. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or

by hand-floating if area is small or inaccessible to power units. Check and level surface plane as required to obtain floor flatness and levelness. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

5. Medium Broom (Non-Slip) Finish: After floating, provide a non-slip broom finish to exterior intermediate stair landing, stair treads and exterior structural concrete pads, unless noted otherwise.

6. Trowel Finish: Provide a trowel finish to equipment building and centrifuge building interior slabs on grade. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance. Grind smooth surface defects which would telegraph through applied floor covering system.

7. Burnished Finish: Provide a burnished finish (or similar) on the floors of the electrical/MCC, mechanical and server rooms. Typically this finish is achieved by repeatedly troweling the concrete floor until it has a mirror-like appearance. Finished result shall have a glossy appearance.

8. Where surfaces are to receive a specialty paint, coating or finish product, the method of finishing the concrete surface shall be coordinated and confirmed by the manufacturer of the paint, coating or finishing products. The following areas must be coordinated:

    a. Equipment Building slab on grade and the bottom 6 inches of the interior face of the walls of the equipment support room, equipment room and chemical room (ground floor) shall receive a corrosion and abrasion resistant coating of Stonchem, identified in the Paintings and Coatings Specification.

    b. The Equipment Building 2nd floor exterior slab, including the landing at the top of the stairs, the control room, store room and bathroom floors shall receive a decorative, chemical and abrasion resistant coating of Stontec UTF, identified in the Paintings and Coatings Specification.

    c. The interior walls and base slab of the basins and underside of all concrete walkways over the basins shall receive waterproof or anti-corrosion coating systems, as detailed in the Paintings and Coatings Specification.

3.8 CONCRETE CURING

A. Curing shall be provided by either a moisture cure or membrane cure, in accordance with the requirements listed herein.

B. Unformed Surfaces shall be moisture cured for a minimum of 7 days. Following initial period, the use of membrane curing compounds may be used for subsequent curing.

C. Horizontal Formed Surfaces shall be moisture cured for a minimum of 7 days. Following initial period, the use of membrane curing compounds may be used for subsequent curing.

D. Vertical Formed Surfaces shall be either moisture cured for a minimum of 7 days or cured via membrane curing compound.

E. Non-Structural Concrete: Sidewalks, curbs & maintenance pads may be cured with a membrane curing compound in addition to any of the moisture curing methods listed herein. During hot weather concreting, if a curing compound is used, the non-structural slabs shall still be moist cured for 12 hours immediately following initial set.

F. For **moisture cure**: Immediately after placement and finishing, provide moisture curing by one (1) of the methods below. Forms shall be left in place for a minimum of 7 days during moisture curing.

1. Keep concrete surface continuously wet by covering with water.

2. Continuous water-fog spray.

3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

4. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

Hot Weather Curing: During hot weather concreting keep forms moist and covered with plastic during the initial 7 day curing period. Hot weather curing shall be in accordance with ACI 305

G. For **membrane cure**: Immediately after placement and finishing, concrete shall be protected from moisture loss for not less than 7 days. For surfaces not in contact with forms, curing compound shall be uniformly applied after water sheen disappears from the concrete. Formed surfaces shall receive an application of curing compound if forms are removed during the 7 day curing period. Curing compound shall not be applied during rainfall.

1. Apply one (1) coat of specified curing compound to concrete at the manufacturer's recommended rate. Apply uniformly in continuous operation by power-spray or roller. Care shall be taken to prevent application to joints where concrete bond is required, to reinforcement steel and to joints where joint sealer is to be placed. The compound shall form a uniform continuous coherent film which will not crack or peel and shall be free from pinholes and other imperfections. Concrete surfaces subjected to heavy rainfall within 3 hours after curing compound has been applied shall be resprayed by above method and at the above coverage at no additional expense to Owner.

2. Do not use membrane curing compounds on concrete surfaces which are to receive liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting, or other coatings and finish materials, unless the Contractor obtains written verification from the manufacturer that his product is compatible with the curing compound.

H. No pedestrian traffic shall be allowed over the surface for 7 days unless surface is protected by planks or plywood. The protection shall not be placed until at least 24 hours after application of curing materials (if applicable). No vehicular or equipment traffic shall be allowed over the surface for 30 days.

I. Protect concrete by suitable methods to prevent damage by mechanical injury or excessively hot or cold temperatures.

3.9 MISCELLANEOUS CONCRETE ITEMS

A. Interior Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.

C. Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on Drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement. Refer to Concrete Unit Masonry Specification 04 22 00 for additional information.

3.10 CONCRETE SURFACE REPAIRS

A. Formed Surfaces: Normal form tie holes shall be filled with a sand-cement grout applied with a bonding agent. Defective areas due to spalls, air bubbles, honeycombing, or segregation with a void depth (after weak material is chipped out) greater than or equal to 1/2" shall be repaired with a concrete repair grout specified in this Section. The defective area shall be chipped out to solid concrete such that the thickness of patching material is at least 1/4" all around. Do not feather-edge. At defective areas exposed-to-view, the Engineer may substitute a sand-cement grout applied with a bonding agent to more closely match the color of the wall.

B. Slabs:

1. Repair spalls and holes by sawcutting with square cuts and chipping to a minimum depth of 1/2" and patching with a concrete repair grout specified in Products section of this specification. Do not feather-edge.

2. Cracks in the slabs on grade up to ¼" wide are to be filled with sealant listed in Products section of this specification. Follow manufacturer's recommendations.

Engineer shall be consulted for investigation and repair of cracks in slabs on grade that are larger than ¼" wide.

3. Cracks in the structural slabs and walls up to 1/8" wide are to be filled with sealant listed in the Products section of this specification. Follow manufacturer's recommendations for preparation and installation. Engineer shall be consulted for investigation and repair of cracks in structural slabs and walls that are larger than 1/8" wide.

4. Severely defective areas which cannot be repaired by one of the above methods shall be removed and replaced at the Contractor's expense.

C. Voids in concrete surfaces resulting from the removal of temporary anchors, shall be repaired with a concrete repair grout specified in Products section of this specification, per manufacturers recommendations.

D. For surface preparation and installation of concrete repair grouts, follow manufacturer's recommended procedures.

3.11 FIELD QUALITY CONTROL

A. Field sampling and testing shall be performed by an independent testing lab. Samples of concrete shall be taken at random locations from work and at such times to represent quality of materials and work throughout the project. The laboratory shall provide necessary labor, materials, equipment, and facilities for sampling concrete and for casting, handling and storing concrete samples at site of work. Sampling of concrete will be in accordance with ASTM C172. Samples for pumped concrete shall be taken at the hose discharge point. Samples for other concrete shall be taken at the hopper of concreting equipment or transit mix truck.

B. Contractor shall pay for the following services when required:

1. Additional testing and inspection required because of changes in materials or proportions requested by the Contractor.

2. Additional testing of materials or concrete occasioned by their failure by test or observation to meet specification requirements. For example, if compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C 42 and any other load tests acceptable to the Engineer. Costs of such tests will be borne by the Contractor.

C. To facilitate testing and observation, Contractor shall advise Owner and designated testing agency sufficiently in advance of operations to allow for the assignment of personnel and for completion of quality tests and checking of forms.

D. Strength Tests:

1. General – Strength of the concrete will be verified by the testing laboratory during placement of concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site.

2. Frequency – As a minimum, one set of four standard cylinders shall be cast of each class of concrete based on the most stringent of the following requirements as applicable:

   - for each 50 cubic yards or less
   - for each 4,000 square feet of surface area
   - for each day a pour is made

3. Lab Testing – Testing of specimens for compressive strength shall be made in accordance with ASTM C39. Tests shall be made at 3, 7 and 28 days from time of casting. One test cylinder from each group of six shall be tested at the end of 3 and 7 days and three shall be tested at the end of 28 days. One cylinder will be held in reserve. The 28-day strength test result shall be the average of the strengths of three test cylinders (cast from material taken from a single load of concrete) at 28 days.

4. Acceptance of Concrete Strength – Strength level of concrete will be considered satisfactory so long as the average of all sets of three consecutive strength results equal or exceed specified compressive strength and not more than 10% of strength test results shall have values less than specified value. No individual strength test shall be less than the specified compressive strength by more than 500 psi.

E. Slump Tests – The slump shall be as specified when measured in accordance with ASTM C 143. Samples for slump determination shall be taken from the concrete during placing. Tests shall be made at the beginning of concrete placing operations and at subsequent intervals to insure specification requirements are met. When concrete is pumped, slump tests shall be taken from the discharge end of pump hose. Slump tests shall also be performed whenever standard cylinders are cast.

F. Temperature and Air Content Tests: Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Test hourly when air temperature is 40º F and below and when 80º F and above. Whenever standard cylinders are cast, temperature tests shall be performed. Air content tests shall be in accordance with ASTM C 231 and measured whenever standard cylinders are cast.

G. Contractor responsibilities regarding test specimens are as defined in ACI 301, including, but not limited to, the following:

1. Contractor shall provide and maintain adequate facilities on the project site for safe storage and initial curing of concrete test specimens as required by ASTM C 31/C 31M for the sole use of the testing agency.

2. Test specimens shall be stored and cured on site in a curing box, within a temperature range of 60-80 degrees Fahrenheit, without the loss of moisture, unless otherwise approved by Engineer.

H. Testing agency shall secure samples on the site at a location agreeable to both the testing agency and the Contractor. If samples are missing when collected by testing agency, Contractor shall compensate Owner in the amount of $1,000 per missing sample. Said compensation shall be deducted from the Contract Amount by Change Order. Contractor shall also be responsible for the cost of coring and testing the concrete from which the missing samples were taken, at the direction of the Engineer, as well as the cost to repair the cored areas.

I. Substandard Concrete: Any concrete furnished under this Specification that fails to reach the required design compressive strength after 28 days, as evidenced by the compressive strength test specified herein, shall be considered substandard.

1. The procedure specified in ACI 318 and 350 (as applicable) for the Evaluation and Acceptance of Concrete shall be used to determine if the substandard concrete is to be removed and replaced. The Engineer shall make the final decision. Any substandard concrete which is removed and replaced shall be done so at the Contractor's expense.

2. For substandard concrete which is left in place, the Contractor shall compensate the Owner an amount of $0.10 for each psi that the actual 28-day concrete strength is below the specified compressive strength for each cubic yard of concrete in the pour. The strength of concrete for a particular pour shall be the average of all but the one (1) lowest of the 28-day compression tests for that pour. Said compensation shall be deducted from the Contract Amount by Change Order.

3.12 WATER TIGHTNESS TESTING

Upon completion of finishing and curing, and prior to application of waterproof and anti-corrosion coatings, hydrostatic tests (HST), in accordance with ACI 350.1, shall be conducted on the 6 Basin structures, as detailed herein.

A. General:

1. Coordinate timing and procedures for obtaining testing water and structure testing with the Owner and Engineer, well in advance of the actual testing.

2. At least 30 days prior to conducting tests, prepare a Water Tightness Testing Program and submit to Engineer for review and acceptance. Program shall include timeline for installation and finalization of concrete, curing method(s) of concrete structures to be tested, duration of curing, and testing sequence for filling and monitoring specific Basins.

3. Test water shall be potable and shall be provided by the Contractor.

4. All labor, equipment and materials shall be supplied by the Contractor.

5. No backfill shall be placed against the walls of the basins until hydrostatic testing is complete and Engineer has authorized backfilling to occur.

B. Preparation:

1. Ground water level shall be brought to a level below that of the top of the base slab and kept at or below that elevation throughout the test.

2. Thoroughly clean the structure to be tested of dirt, mud and construction debris prior to initiating the hydrostatic tests. The floor and sumps shall be flushed with water to provide a clean surface, ready for testing.

3. Inspect the surfaces of all Basins to be tested for potential leakage paths such as cracks, voids etc. and repair such deficiencies, as directed in this Specification. Document any deficiencies with photographs and a corresponding location system.

4. Confirm presence and adequacy of seals around gates, valves, outlets and pipe penetrations. Engineer shall inspect for acceptance prior to commencement of testing.

5. Pipe wall sleeves with waterstops and seals should be fully installed and securely capped prior to testing.

6. Weir openings shall be temporarily covered for purpose of testing.

7. Install two evaporation and precipitation measurement devices, as defined in ACI 350.1.

8. Two thermometers shall be installed on the Basin being tested for the purpose of monitoring air temperature throughout testing. A thermometer to measure the water temperature shall also be provided.

C. Testing:

1. Conditions of Testing:

a. Do not begin initial filling of concrete structures until all concrete elements of the structure have attained the design compressive strength of the concrete. Contractor shall assume this duration to be 28 days from placement, but Engineer reserves right to modify this duration based upon concrete test results and selected curing method(s).

b. Do not begin initial filling of concrete structures until all walls and base slabs have been coated with the designated waterproofing and corrosion resistant systems and proper curing time has been achieved (per manufacturer).

c. The test measurements shall not be scheduled for a period when the forecast is for a substantial change in the weather pattern (35 degree temperature differential from commencement to conclusion). The test

shall also not be scheduled when the weather forecast indicates the water surface may freeze before the test is completed.

d. Initial filling rate shall conform to the requirements of ACI 350.1 and shall not exceed four (4) feet per hour.

e. Contractor shall notify Engineer a minimum of three (3) days prior to testing.

2. Execution:

a. Hydrostatic tests shall include HST-VIO followed by HST-100, as defined in ACI 350.1.

b. Basins shall be tested independently as follows (refer to Drawings for basin names and locations):

i. Anoxic Basin, one Membrane Basin and one Pre-Aeration Basin (not adjacent to the Membrane Basin being tested) shall be tested first and in conjunction with each other.
ii. Remaining Membrane Basin and Pre-Aeration Basin shall be tested second.
iii. Chlorine Contact Basin can be tested in conjunction with any of the above.

c. Where possible, contractor shall recycle test water from the Basin(s) most recently tested into the Basin(s) scheduled to be tested next. If excess water remains in the Basin(s) most recently tested, it shall be drained and/or pumped out.

d. Contractor shall wait to perform tests on designated Basin(s) until the surrounding Basins walls and slabs are dry. Contractor may use fans to dry out basins quickly, if desired.

e. Photographs of all Basins, clearly identifying the Basin(s) to be tested, shall be taken just prior to testing to document that the surrounding Basins are dry. If surrounding Basins are not dry, test results shall be voided.

f. The Basin(s) to be tested shall be filled with water at a maximum rate of four (4) feet per hour, to elevation of 2' below the top and shall be left to stabilize for three (3) days.

g. Damp spots and standing water on surrounding surfaces due to spillage during process of filling the Basin(s) shall be absorbed and/or dried prior to commencement of testing so as not to be confused with leakage.

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h. Conduct HST-VIO: From the time that test Basin(s) are filled and throughout the duration of the test, all wall and slab surfaces surrounding the test Basin(s) shall be inspected daily for visible indications of leakage. If, during the first three (3) days of filling (prior to commencement of test) any flow of water is observed from the Basin exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired. After

testing has begun, any visible indications of leakage shall be viewed as failure.

i. After three (3) days, the water level in the test Basin(s) shall be measured and recorded and the test shall begin. Measure water surface elevation at not less than four (4) locations, 90 degrees apart. Record water temperature 18 inches below the surface for all measurements.

j. The vertical distance to the water surface shall be measured from a fixed point on the tank above the water surface. Measurements shall be taken at the same locations each time they are recorded.

k. Conduct HST-100: Test shall consist of measuring the liquid level over the next **48 hours** to determine any change that occurs, taking measurements at 24 hour intervals. The maximum permissible loss is **0.1 percent of water volume**. The loss of volume shall be determined by measuring the drop in water surface elevation and calculating the change in volume of the contained water.

l. If the change observed in 48 hours exceeds the maximum allowable, the test shall be extended to a total of five (5) days with testing every 24 hour period. If, at the end of the five (5) days, the average daily change has not exceeded the maximum allowable loss, the test shall be considered satisfactory.

m. Engineer shall be present at the end of the 24 hour test period to observe all wall and slab surfaces surrounding test Basin(s) for visible indications of leakage.

n. Evaporation and rainfall during testing shall be measured and recorded at commencement of test and every 24 hours, in conjunction with the water level measurements.

o. Air temperature shall be recorded at the commencement of testing and again every six (6) hours throughout testing.

p. If, at any time during the filling and/or testing procedure, visible signs of leakage are observed, photographs shall be taken and Engineer shall be notified immediately. If, for safety reasons, Engineer deems it necessary, the testing process may be stopped.

3. Reports: Testing reports shall be provided for each Basin tested and shall include the following information:

a. Date and time of commencement of test.

b. Initial water elevation and corresponding volume (taken at 4 locations).

c. Subsequent water elevations (taken at 4 locations every 24 hours) and corresponding volume, calculated using the average of the four (4) elevations.

d. Initial water levels and volume of evaporation and precipitation sample.

e. Subsequent water levels of evaporation and precipitation sample.

f. All air and water temperatures readings throughout testing and the times at which they were recorded.

g. Calculation showing conformance or nonconformance with maximum loss.

h. Date, time, duration and measurement of rainfall.

4. Failure: The following conditions shall be considered as NOT meeting criteria for acceptance, regardless of the actual loss of water volume measured:

a. Water volume loss exceeding allowable.

b. Ground water leakage into the structure.

c. Structures which exhibit water flowing from the Basin(s) or from beneath the foundation (except for under-drain systems).

d. Presence of damp spots on surfaces. Damp spots are defined as spots where moisture can be picked up by a dry hand from the exterior surface.

5. Repairs and Retesting:

a. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.

b. Structures failing the hydrostatic tests and not exhibiting visible leakage may be retested after an additional stabilization period of not less than three (3) days. Basins that fail the second test shall be investigated and repaired prior to additional tests.

c. Repair structures which fail the hydrostatic tests and structures showing visible leakage under the direction of the Engineer.

d. The expense of repairs and retesting, including consultation of the Engineer, shall be borne by the Contractor at no additional cost to the Owner.

6. Conclusion:

a. Following successful completion of all hydrostatic testing, the test water shall be disposed of by draining and/or pumping out of the Basins.

b. All surfaces shall be dry prior to application of waterproof and anti-corrosion coatings. The coating manufacturers shall be consulted regarding the recommended moisture content of the concrete surfaces to be coated. This may entail moisture testing of the concrete surfaces. If surfaces are too moist for coating, Contractor shall follow procedural

recommendations from coating manufacturers to obtain acceptable levels for application of coatings.

END OF SECTION

INDEX TO

SECTION 03 40 00

PRECAST CONCRETE

SECTION 03 40 00

PRECAST CONCRETE

PART 1 – GENERAL

1.01 PURPOSE

A. This Section intended to provide Contractor with applicable information related to any precast boxes and manholes required for the site. It does not apply to precast concrete piles.

1.02 SCOPE

A. This Section is limited to precast concrete structures.

1.03 REFERENCES (LATEST REVISION)

A. Not Used

1.04 SUBMITTALS

A. Submittals for Review:

1. Calculations and Technical Design Data (including codes & loads) for each precast item, signed and sealed by a professional engineer registered in the State of South Carolina.

2. Shop Drawings and calculations for each precast item.

a. Shop Drawings that clearly show dimensions, elevations, sizes, proposed details, and concepts for slabs, precast boxes and manholes, and their included accessories, signed and sealed by a professional engineer registered in the State of South Carolina.

B. Informational Submittals:

1. For Precasting Manufacturers Not Listed in Article Quality Assurance:

a. Experience record on production of precast concrete as shown, with information on precasting plant that will indicate capability to satisfactorily perform the Work.

b. Evidence of current PCI plant certification.

2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.

3. Test Reports:

a. For precast manufacturer's concrete test cylinders.

b. Inspection of installed units.

1.05 QUALITY ASSURANCE

A. Qualifications of Precasting Manufacturers:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with three years' experience producing precast concrete products of quality specified.

2. Precast Plant(s): PCI certified plants with current certification.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Formwork, Reinforcing, Cement, Aggregates, Admixtures, Grout:

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

B. Embedded Items:

1. ASTM A36 steel.

2. Anchor Studs: Headed anchor studs (HAS), deformed bar anchors (DBA), or threaded studs as manufactured by Nelson Stud Welding Co., Lorain, OH. '

3. Furnish inserts for lifting tilt-up walls, bolting stiffeners, attaching braces, and as otherwise required.

2.02 CONCRETE MIX

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

B. Design Strength: 4,500 psi at 28 days, minimum.

C. Water/Cement Ratio: 0.40 maximum.

D. Durability Requirements: Concrete mix shall be suitable for moderate sulfate exposure per Table 4.3.1 of ACI 318.

2.03 DESIGN & CONSTRUCTION REQUIREMENTS

A. Structural Precast Units:

1. Design for loads specified on the structural Construction Drawings:

2. Conform to recommendations in the following standards and specifications:

   a. PCI MNL-116, Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.

   b. PCI MNL-l20, PCI Design Handbook – Precast and Prestressed Concrete.

   c. PCI MNL-l35, Tolerance Manual for Precast and Prestressed Concrete Construction.

   d. ASTM C478, Standard Specifications for Precast Reinforced Concrete Manhole Sections.

   e. ASTM C890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

   f. ASTM C913, Standard Specifications for Precast Water and Wastewater Structures.

3. In event of conflicting criteria, most severe governs.

2.04 FABRICATION

A. General:

1. Comply with PCI MNL-116, Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.

2. Reinforcing Steel:

   a. Place in position before concrete is cast.

   b. Keep clean and free from oil or other substances harmful to bond.

3. Forms: Produce smooth surfaces.

4. Concrete: Deposit, vibrate, finish, and cure in accordance with recommended practices of ACI 304R. Steam curing is permitted.

5. Coordinate dimensions, determine type, quantity, size, and location of, and furnish necessary embedded items in precast concrete. Coordinate location of embedded items in cast-in-place concrete necessary to connect precast items.

B. Surface Finish for Precast Boxes & Manholes: smooth.

2.05 SOURCE QUALITY CONTROL

A. Prepare minimum three standard concrete test cylinders for each 50 cubic yards or fraction thereof of concrete placed in the precast work in accordance with ASTM C31.

B. Test and record concrete strengths as required in Section 03 30 00 Cast-In-Place Concrete.

PART 3 – EXECUTION

3.01 ERECTION

A. Verify that anchorage inserts are in correct locations.

B. Handle and erect precast concrete with care as recommended by manufacturer.

C. Erect precast units plumb, straight, level, square, and in proper alignment.

D. Fasten units securely in place and brace to maintain position, stability, and alignment until permanently connected and structure is complete and stable.

E. Field Cutting: Not allowed without prior approval of Contractor.

3.02 PATCHING

A. Mix and place patching mixture to match color and texture of surrounding concrete and to minimize shrinkage.

B. Demonstrate patching method and obtain acceptance and approval.

3.03 CLEANING

A. After installation, clean soiled precast concrete surfaces with detergent and water, using fiber brush and sponge.

B. Use acid solution only to clean particularly stubborn stains after more conservative methods have been tried unsuccessfully.

C. Use extreme care to prevent damage to precast concrete surfaces and to adjacent materials.

D. Rinse thoroughly with clean water immediately after using cleaner.

3.04 FIELD QUALITY CONTROL

A. Inspection:

1. With Engineer's Inspector, inspect units for chips, cracks, and other damage.

2. Record location and condition of damaged or nonmatching units.

B. Resolution:

1. Repair damage to satisfaction of Engineer.

2. Remove units with damage or repairs not acceptable to Engineer.

3. Install new acceptable units in place of those removed.

4. Perform reinspection and obtain acceptance by Engineer.

3.05 PROTECTION

A. Protect precast units from chipping, spalling, cracking, or other damage to the units after delivery to Site.

B. After erection, protect units from damage.

END OF SECTION

SECTION 04 22 00

CONCRETE UNIT MASONRY

PART 1 – GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):

a. 530.1/ASCE 6/TMS 602, Building Code Requirements for Masonry Structures and Specifications for Masonry Structures and Related Commentaries.

b. ACI SP-66, ACI Detailing Manual

2. ASTM International (ASTM):

a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

b. A153, Standard specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

c. A167, Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

d. A615, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

e. C33, Standard Specification for Concrete Aggregates.

f. C62, Building Brick (Solid Masonry Units Made from Clay or Shale)

g. C67, Sampling and Testing Brick and Structural Clay Tile

h. C90, Standard Specification for Loadbearing Concrete Masonry Units.

i. C91, Masonry Cement

j. C94, Ready Mixed Concrete

k. C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

l. C144, Standard Specification for Aggregate for Masonry Mortar.

m. C150, Standard Specification for Portland Cement.

n. C270, Standard Specification for Mortar for Unit Masonry.

o. C476, Standard Specification for Grout for Masonry.

p. C494, Chemical Admixtures for Concrete

q. C578, Rigid, Cellular Polystyrene Thermal Insulation

r. C744, Standard Specification for refaced Concrete and Calcium Silicate Masonry Units.

s. C780, Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry

t. C1019, Sampling and Testing Grout

u. C1072, Measurement of Masonry Flexural Bond Strength

v. C1142, Extended Life Mortar for Unit Masonry

w. C1289, Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board

x. C1314, Standard Test Method for Compressive Strength of Masonry Prisms.

y. C2287, Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds

z. E514, Standard Test Method for Water Penetration and Leakage through Masonry.

3. Brick Institute of America (BIA).

4. International Code Council (ICC):

a. International Building Code (IBC) Chapter 21.

b. ICC Evaluation Service (ICC-ES) Reports.

5. National Concrete Masonry Association (NCMA).

1.02 SUBMITTALS

A. Submittals for Review:

1. Product Data:

a. Accessories.

b. Concrete Masonry Units (CMU).

c. Mortar - include required environmental conditions, admixture limitations and manufacturer's instructions for packaged dry mortar installation.

d. Reinforcement.

2. Certificates:

a. Manufacturer letters of certification stating materials meet or exceed the specified requirements.

B. Informational Submittals:

1. Statement of Acknowledgement of Quality Assurance Plan in accordance with IBC Section 1705.3.

1.03 QUALITY ASSURANCE

A. Compliance: Comply with the requirements and criteria of the NCMA, BIA, ASTM C90, ASTM *C216,* and ACI 530.1 for masonry finish and appearance, dimension tolerances, tolerances of construction, joint tolerances, and wall plumb tolerances.

B. Spare Vibrator: Maintain at least one spare vibrator on site at all times.

C. Bracing and Scaffolding: Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by local code.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when ambient temperature is below 32 degrees F on a rising temperature, or below 40 degrees F on a falling temperature, or when there is a probability of such conditions occurring within 48 hours, unless written approval of procedure for protection from freezing is obtained from Engineer. Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.

B. Moisture Protection: Protect masonry construction from loss of moisture during curing period of 7 days when ambient air temperature is 90 degrees F or greater and when relative humidity is less than 50 percent.

PART 2 – PRODUCTS

2.01 MASONRY UNITS

A. General:

1. Furnish or cut special shapes for corners, jambs, lintels, and other areas shown or required.

2. Special units shall match properties of standard units.

3. Where units are placed so end of unit is exposed, such as at a corner or intersection, exposed end of that block shall have surface to match color and texture of sides of other units.

4. Furnish sound, dry, clean units free of cracks, prior to placing in structure.

5. Vertical Cells to be Grouted: Capable of alignment sufficient to maintain clear, unobstructed continuous vertical cell dimensions in accordance with ACI 530.1, Table 7.

6. Masonry unit size and shape shall allow for all placement patterns to prevent materials, such as grout or poured insulation, from escaping from cell being filled to adjacent cells where material is not intended to be placed.

B. Plain Face Concrete Masonry Units (CMU):

1. Load Bearing Units: ASTM C90: lightweight, hollow block, grouted as indicated.

2. Nominal Size: 16 inches long by 8 inches high by thickness shown on Drawings.

3. Minimum Compressive Strength, f'_m: 1,500 psi

4. Color of Units: Natural.

5. Surface Texture: Smooth.

C. Decorative Concrete Masonry Units:

1. Texture: Split face and smooth face, as indicated.

2. Colors: As selected by Architect.

3. Manufacturers: Subject to compliance with requirements, provide selected products by one of the following.

a. Cemex.

b. Johnson Cement Co.

c. Trenwyth Industries/Oldcastle.

D. Integral Water Repellent for Decorative Concrete Units: Provide units made with integral water repellent for exposed units. Provide one of the following:

1. Headwaters Construction Materials; Eucon BlockTite.

2. Grace Construction Products; Dry-Block.

3. BASF; Rheopel.

2.03 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM CI50, Type I.

B. Lime: ASTM C207, Type S hydrated.

C. Aggregates:

1. Mortar: ASTM C144, sand.

2. Grout: ASTM C404.

D. Water: Fresh, clean, and potable.

E. Colored Cement for Decorative Concrete Masonry: Packaged blend made from mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients. Provide one of the following:

1. Essroc; Flamingo Color Masonry Cement.

2. Holcim; Rainbow Mortamix Custom Color Masonry Cement.

3. Lehigh; Lehigh Custom Color Masonry Cement.

F. Mortar Mix:

1. Mortar for Unit Masonry, Type S in accordance with ASTM C270.

2. Minimum 28-day compressive strength of 2,100 psi.

G. Grout:

1. For bond beams, lintels and vertically reinforced cells.

2. Grout shall be in accordance with ASTM C476, premixed type in accordance with ASTM C94.

3. Consistency required to fill completely the volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less;

coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

4. Minimum 28-day compressive strength of 3,000 psi. Slump: 8 inches to 11 inches.

2.04 REINFORCEMENT

A. Horizontal Joint Reinforcement:

1. Truss or ladder type, ASTM *A82,* 9ga, galvanized.

2. Reinforcement: Clean and free from loose rust, scale, and coatings that reduce bond.

3. Furnish special manufactured corner and wall intersection pieces.

4. Manufacturer: Dur-O-Wal, Inc., Aurora, IL.

B. Deformed Bars: As specified in Section 03 30 00 Cast-In-Place Concrete.

2.05 PREFORMED CONTROL JOINTS

A. Solid rubber cross-shape extrusions as manufactured by:

1. Wire-Bond, Rubber Control Joint.
2. Hohmann and Barnard, Inc; RS Series.

PART 3 – EXECUTION

3.01 GENERAL

A. Protect masonry construction to prevent efflorescence. Provide measures to prevent moisture from entering incomplete walls.

3.02 PREPARATION

A. Prepare surface contact area of foundation concrete for initial mortar placement by one of following methods:

1. Sandblasting foundation and reinforcing dowels after concrete has fully cured to remove laitance and spillage and to expose sound aggregate.

2. Water blasting foundation and reinforcing dowels after concrete has partially cured to remove laitance and spillage and to expose sound aggregate.

B. Clean surfaces of loose material prior to initial mortar placement.

C. Prevent surface damage to foundation concrete that will be exposed to view outside of contact area.

3.03 LAYING MASONRY UNITS

A. General:

1. Conform to building code applicable to this Project and as supplemented by these Specifications.

2. Do not start laying masonry units unless foundation wall is plumb within 1/4 inch in 10 feet or not straight within *5/16* inch in 10 feet.

3. Finish Tolerances (Measured on Interior surfaces):

d. Maximum permissible variation from plumb of masonry wall or line of joints in masonry wall: 1/16 inch per foot of height and *1/4* inch in total height of wall.

e. Maximum permissible variation from horizontal line along base of wall or for lines of horizontal joints: *1/16* inch per block and *1/4* inch per 50 feet of wall with proportionately greater tolerance for longer walls up to *1/2* inch in total length of wall.

4. Place units with chipped edges or corners such that chipped area is not exposed to view.

B. Wall Units:

1. General:

a. If necessary to move a unit after set in-place, remove from wall, clean, and set in fresh mortar.

b. Toothing of masonry units is not permitted.

2. Running Bond:

a. Unless otherwise shown, lay up walls in straight, level, and uniform courses using a running bond pattern.

b. Place units for continuous vertical cells and mortar joints to prevent materials, such as grout or poured insulation, from escaping from cell being filled to adjacent cells where material is not intended to be placed.

3. Corners: Lay standard masonry bond for overlapping units and grout solid.

4. Intersecting Walls: Bond with reinforcement, not with masonry bond.

C. Special Shapes:

1. Provide and place such special units as corner block, doorjamb block, lintel block fillers, and similar blocks as may be required.

2. Use required shapes and sizes to work to corners and openings, maintaining proper bond throughout wall.

3.04 BUILT-IN ITEMS

A. Position door frames, windows, vents, louvers, and other items to be built in wall, and construct wall around them.

B. Install masonry anchors to secure items to wall.

C. Fill spaces around items with mortar or grout.

D. Do not place electrical, instrumentation, or water conduits in a cell containing reinforcement, unless approved in writing by Engineer. Pipes, sleeves, and conduits shall not be placed closer than three diameters, center-to-center, nor shall they impair strength of construction.

3.05 MORTAR JOINTS

A. General:

1. Straight, clean, with uniform thickness of 3/8 inch.

2. Horizontal and vertical mortar joints shall have full mortar coverage on face shells.

3. Vertical Head Joints:

a. Butter well on each unit for a width equal to face shell of unit, shove tightly so mortar bonds well to both units.

b. Solidly fill joints from face of block to at least depth of face shell.

4. As units are laid, remove excess mortar from grout space of cells to be filled.

5. Place mortar before initial setting of cement takes place. Do not retemper mortar that has started to set or is not used within one hour. Retempering of colored mortar is not allowed.

B. Exposed Joints:

1. Tool joints exposed to view after final construction, unless otherwise noted or shown.

2. Cut joints flush and as mortar takes its initial set tool to provide a concave joint.

3. Perform tooling when mortar is partially set but still sufficiently plastic to bond.

4. Perform tooling with tool that compacts mortar, pressing excess mortar out rather than dragging it out.

5. Rake out joints that are not tight at time of tooling, point, and then tool.

6. Rake and tool joints at split-face surfaces interior and exterior.

C. Concealed Joints: Strike flush with no further treatment required.

3.06 CONTROL JOINTS

A. Preformed Control Joints:

1. Omit mortar from vertical joints.

2. Place rubber control joint material as wall is built.

3. After wall is grouted, cured, and cleaned, install backing rod and sealant as specified in Section 07 92 00, Joint Sealants.

4. Place and tool sealant to match depth of typical joint.

5. Maximum spacing from all corners shall be 20 times wall thickness, maximum spacing between joints shall be 40 times wall thickness.

3.07 REINFORCING

A. Foundation Dowels:

1. Size, number, and location of foundation dowels shall match vertical wall reinforcing, unless otherwise noted.

2. When foundation dowel does not line up as intended, with vertical core, do not slope more than 1 horizontal to 6 vertical to bring it into alignment.

B. Vertical Reinforcing:

1. Use deformed bars.

2. Hold in position near the ends of bars by wire ties to dowels or by reinforcing positioners.

3. Lap reinforcing bars as shown, where spliced and wire tie together.

4. Minimum Bar Clearance: One bar diameter from masonry and from additional parallel bars in same grout space.

5. Hold in position at maximum intervals of 160 bar diameters by reinforcing positioners.

C. Horizontal Reinforcing:

1. Use deformed bars.

2. Lay on webs of bond beam units and place as wall is built.

3. Lap reinforcing bars as shown, where spliced and wire tie together.

4. Minimum Bar Clearance: One bar diameter from masonry and from additional parallel bars in same grout space.

5. Terminate reinforcing bars 2 inches clear from control joints as shown.

D. Horizontal Joint Reinforcement:

1. Use for stack bond.

2. Provide in addition to typical wall reinforcing steel.

3. Space maximum 16 inches apart, vertically.

4. Lap ends 6 inches minimum.

5. At control joints make reinforcement discontinuous.

6. Use manufactured corner and other wall intersection pieces.

3.08 MORTAR PRODUCTION

A. General:

1. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use. Mix ingredients 3 minutes to 5 minutes after all ingredients are introduced.

2. Provide volumetric control by using batching box or similar measuring device. Do not use shovel to introduce materials directly into batch.

3. Maintain sand uniformly damp immediately before the mixing process.

4. Use cool mix water.

5. Do not use anti-freeze compounds to lower the freezing point of mortar.

6. If water is lost by evaporation, re-temper only within two hours of mixing.

3.09 GROUTING

A. General:

1. Do not mix, convey, or place with equipment constructed of aluminum.

2. Secure vertical and horizontal reinforcement, ties, bolts, anchors, and other required embedments in place; inspect and verify before placing grout.

3. Grout beams over openings in one continuous operation.

4. Maintain vertical alignment in ACI 530.1, Table 7.

5. Maximum grout pour shall be 5'-0", unless otherwise approved, in writing, by Engineer.

6. Place grout as soon as possible after mortar has set to reduce shrinkage cracking of vertical joints.

7. Vertical Reinforcement:

   a. First wire tie to foundation dowels, then build wall around it.

   b. Provide reinforcing positioners or a proved cross bracing to secure top of steel in place.

   c. Do not drop in vertical steel after block is laid, unless reinforcing positioners are provided in the course above previously grouted course.

B. Grouting Requirements:

1. Brace masonry to resist wet grout pressure.

2. Do not start grouting until wall has cured for 24 hours, minimum.

3. Partial Grouting Requirements:

   a. Walls Not Requiring Solid Grouting: Fill cells containing reinforcing steel, anchor bolts, and other embedded items as shown with grout.

   b. Construct cells to be filled to confine grout within cell.

   c. Cover tops of unfilled vertical cells under a bond beam with metal lath to confine grout fill to bond beam section.

4. Form horizontal construction joints between pours by stopping grout pour 1–1/2 inches below a mortar joint, except at a bond beam; stop pour 1/2 inch below top of masonry unit.

5. Partial Grouting with Insulation Fill:

   a. Where cells of masonry units are to receive masonry fill insulation in some cells and to receive grout in some cells, provide continuous mortar on block webs on each side of cells to be filled with grout to ensure insulation without enter grout cells.

b. Where bond beams are required with masonry fill insulation and grout, limit pours to less than 5 feet in height.

6. Fully embed horizontal steel with grout in an uninterrupted pour.

7. Do not construct wall more than one course above top of grout pour prior to placing grout.

8. Vibration:

a. Use internal "pencil" type, low energy vibrator to thoroughly consolidate grout and reduce amount of air voids. Do not use concrete vibrators.

b. After waiting sufficient time to permit grout to become plastic, but before it has taken any set, reconsolidate grout.

c. Waiting period will vary depending upon weather conditions and block absorption rates, but under "normal" weather conditions with average masonry units the waiting period should be between 30 minutes to 60 minutes.

9. Cleanouts:

a. Provide for grout pours over 5 feet in height.

b. Provide for sufficient size to permit cleaning of cell, positioning of reinforcing, and inspection at bottom of every vertical cell containing reinforcing.

c. Location: Concealed from view after final construction, unless otherwise approved by Owner.

d. After wall has been inspected and approved and prior to grouting, cap cleanouts in a manner that will seal them from grout *leakage* and provide a flush finish.

3.10 FIELD QUALITY CONTROL

A. Masonry shall be tested by independent testing agency, retained by Owner, in accordance with ASTM C1314, Method B, as modified by ACI 530.1/ASCE 6.

B. Masonry test samples, when required, shall be constructed onsite with same materials and workmanship to be used for Project.

C. Provide adequate facilities for safe storage and proper curing of masonry prisms, mortar samples, and grout samples, as applicable, onsite for first 24 hours, and for additional time as may be required before transporting to test lab.

D. Masonry Testing:

1. Unit Strength Method:

   a. Method and frequency for mortar, grout, and masonry unit sampling and testing in accordance with IBC 2105.2.2.1.

   b. Provide masonry units for test samples required.

E. Corrective Action:

1. If compressive strength tests made prior to construction of permanent structure fail to meet Specifications, adjustments shall be made to mix designs for mortar, or grout, or both, as needed to produce specified strength. Masonry units shall also be tested to verify compliance to requirements of ASTM C90, Type 1.

2. If strength tests performed on materials representative of in-place construction fail to meet Specifications, prisms or cores shall be cut from constructed walls in sufficient locations to adequately determine strength in accordance with IBC 2105.3.

3.11 CLEANING

A. Immediately after completion of grouting, clean masonry surfaces of excess mortar, grout spillage, scum, stains, dirt, and other foreign substances using clean water and fiber brushes.

3.12 PROTECTION OF INSTALLED WORK

A. Do not allow grout and mortar stains to dry on face of exposed masonry.

B. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain or snow is imminent and when the Work is discontinued.

C. Adequately brace walls until walls and roof are completed.

D. Provide sufficient bracing to protect walls against damage from elements, including wind and snow.

E. Protect masonry against freezing for minimum 2 hours after being laid.

F. Protect masonry from damage until final acceptance of the Work. Damaged units will not be accepted.

END OF SECTION

SECTION 05 05 23

WELDING

PART 1 – GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):

   a. *BPVC* SEC V, Nondestructive Examination.

   b. BPVC SEC IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

2. American Society of Nondestructive Testing (ASNT): SNT -TC-IA, Personnel Qualification and Certification in Nondestructive Testing.

3. ASTM International (ASTM): A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

4. American Welding Society (AWS):

   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.

   b. A3.0, Standard Welding Terms and Definitions; Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting and Thermalspraying.

   c. *D1.1/D1.1M,* Structural Welding Code -Steel.

   d. D*1.2/D*1.2M, Structural Welding Code -Aluminum.

   e. D1.3, Structural Welding Code -Sheet Steel. *D1.4/D1.4M,* Structural Welding Code -Reinforcing Steel.

   f. *D1.6/D1.6M,* Structural Welding Code -Stainless Steel.

   g. QCI, Standard for AWS Certification of Welding Inspectors.

1.02 ABBREVIATIONS

A. CJP: Complete Joint Penetration.

B. CWI: Certified Welding Inspector.

C. MT: Magnetic Particle Testing.

D. NDE: Nondestructive Examination.

E. NDT: Nondestructive Testing.

F. PJP: Partial Joint Penetration.

G. PQR: Procedure Qualification Record.

H. PT: Liquid Penetrant Testing.

I. RT: Radiographic Testing.

J. UT: Ultrasonic Testing.

K. VT: Visual Testing.

L. WPQ: Welder/Welding Operator Performance Qualification.

M. WPS: Welding Procedure Specification.

1.03 SUBMITTALS

A. Shop Drawings:

1. Shop and field WPSs and PQRs.

2. NDT procedure specifications prepared in accordance with ASME BPVC SEC V.

3. Welding Data (Shop and Field):

a. Show on Shop Drawings or a weld map complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tails of combined welding and NDE symbols as indicated in AWS A2.4.

b. Distinguish between shop and field welds.

c. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for welds.

d. For pipe fittings, provide a joint weld beveling diagram. Refer to AWS D1.1, Annex G Local Dihedral Angle that can be used to calculate bevels for weld joint details of intersecting pipes.

e. Welding and NDE symbols shall be in accordance with AWS A2.4.

f. Welding terms and definitions shall be in accordance with AWS A3.0.

g. Submit welding data together with shop drawings as a complete package.

B. Informational Submittals:

1. WPQs.

2. CWI credentials.

3. Testing agency personnel credentials.

4. CWI reports.

5. Welding Documentation: Submit on appropriate forms in referenced welding codes.

1.04 QUALIFICATIONS

A. WPSs: In accordance with AWS D1.1 (Annex E Forms).

B. WPQs: In accordance with AWS D1.1 (Annex E Forms).

C. CWI: Certified in accordance with AWS QC 1, and having prior experience with the welding codes specified. Alternate welding inspector qualifications require approval by the Engineer.

D. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.

1.05 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, all Submittals required in this section shall be submitted and approved prior to commencement of welding operations.

PART 2 – PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. The CWI shall be present whenever shop welding is performed. The CWI shall perform inspection, as necessary, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1 or referenced welding code and as follows:

1. Verifying conformance of specified job material and proper storage.

2. Monitoring conformance with approved WPS.

3. Monitoring conformance of WPQ.

4. Inspecting weld joint fit-up and in-process inspection.

5. Providing 100 percent visual inspection of welds.

6. Supervising nondestructive testing personnel and evaluating test results.

7. Maintaining records and preparing report confirming results of inspection and testing comply with the work.

PART 3 – EXECUTION

3.01 GENERAL

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Welding and Nondestructive Testing Table.

B. Welding procedure specifications for all pressure piping shall be qualified for notch toughness by limiting heat input; charpy testing of weld metal and heat affected zone shall be done as a part of the welding procedure qualification. Full-size specimens shall be charpy tested in accordance with ASTM A370 at a test temperature of 30 degrees F. The minimum average energy of the test coupons shall not be less than 25 foot-pounds.

3.02 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. Weld Inspection Criteria:

1. Selection of welds to be tested unless 100 percent NDT is specified herein, shall be as agreed upon between Contractor and Subcontractor.

2. Unless otherwise specified, perform NDT of welds at a frequency as shown below or in the attached table in accordance with the referenced welding codes as follows. In case there is a conflict the higher frequency level of NDT shall apply:

a. Fillet Welds and PJP Groove Welds: 10 percent random MT or PT.

b. All Welds: 100 percent VT.

3. Weld Acceptance:

a. VT:

1) Structural Pipe and Tubing: AWS *D1.1,* Paragraph 6.9, Visual Inspection, Tubular Connections.

2) All Other Structural Steel: AWS D1.1, Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.

3) Stud Connections: AWS *D1.1,* Paragraph 7.8.1.

b. PT or MT:

1) Perform on fillet and PJP groove welds in accordance with AWS *D1.1,* Paragraph 6.10.

2) Acceptance shall be in accordance with VT standards specified above.

3.03 FIELD QUALITY CONTROL

A. The CWI shall be present whenever field welding is performed. The CWI shall perform inspection, as necessary, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1 or referenced welding code and as follows:

1. Verifying conformance of specified job material and proper storage.

2. Monitoring conformance with approved PS.

3. Monitoring conformance of WPQ.

4. Inspecting weld joint fit-up and in-process inspection.

5. Providing 100 percent visual inspection of all welds.

6. Supervising nondestructive testing personnel and evaluating test results.

7. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

3.04 WELD DEFECT REPAIR

A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

3.05 SUPPLEMENTS

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

1. Welding and Nondestructive Testing table.

END OF SECTION

Welding and Nondestructive Testing						
Specification Section	**Governing Welding Codes or Standards**	**Submit WPS**	**Submit WPQ**	**Onsite CWI Req'd**	**Submit Written NDT Procedure Specifications**	**NDT Requirements**
05 12 00 Structural Steel Framing	AWS D1.1, Structural Welding Code – Steel	Yes	Yes	Yes	Yes	100% UT or RT of all CJP groove-and-butt joint welds; 10% MT of all fillet welds; see Section 05 12 00
05 31 00 Steel Decking	AWS D1.1, Structural Welding Code – Steel or AWS D1.3, Structural Welding Code – Sheet Steel	No	No	Yes	No	100% VT; see Section 05 31 00
05 41 00 Structural Metal Stud Framing	AWS D1.1, Structural Welding Code – Steel or AWS D1.3, Structural Welding Code – Sheet Steel	Yes	Yes	Yes	Yes	100% VT; see Section 05 41 00
05 50 00 Metal Fabrications	AWS D1.1, Structural Welding Code – Steel or AWS D1.2, , Structural Welding Code – Aluminum or AWS D1.6, Structural Welding Code – Stainless Steel	Yes	Yes	Yes	Yes	100% VT; see Section 05 50 00
05 51 00 Metal Stairs	AWS D1.1, Structural Welding Code – Steel or AWS D1.3, Structural Welding Code – Sheet Steel	Yes	Yes	Yes	Yes	100% VT; see Section 05 51 00
05 52 00 Metal Railings	AWS D1.1, Structural Welding Code – Steel or AWS D1.2, , Structural Welding Code – Aluminum	No	No	No	No	100% VT; see Section 05 52 00
05 53 00 Metal Gratings	AWS D1.1, Structural Welding Code – Steel or AWS D1.2, , Structural Welding Code – Aluminum	No	No	No	No	100% VT; see Section 05 53 00

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 – GENERAL

1.01 REFERENCES

Provide the structural steel system, including shop primer or galvanizing, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC 325 except as modified in this contract.

1.02 REFERENCES

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

AISC 303	(2000) Code of Standard Practice for Steel Buildings and Bridges
AISC 316	(1989) ASD Manual of Steel Construction
AISC 317	(1992) ASD Manual of Steel Construction, Vol II: Connections
AISC 325	(2001) LRFD Manual of Steel Construction
AISC 326	(2002) Detailing for Steel Construction
AISC 348	(2000) Structural Joints Using ASTM A325 or A490 Bolts
AISC 350	(1999) Load and Resistance Factor Design (LRFD) Specification for Structural Steel Buildings
AISC M018L	(1999) LRFD Manual of Steel Construction, Metric Conversion Volume I
AISC M019L	(1999) LRFD Manual of Steel Construction, Metric Conversion Volume II

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1998) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1	(2004) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 123	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(2004) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 325	(2004b) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 36	(2004) Carbon Structural Steel
ASTM A 490	(2004a) Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A 500	(2003a) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 53	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 563	(2004a) Carbon and Alloy Steel Nuts

ASTM A 572	(2004) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 6	(2004b) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 780	(2001) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 992	(2004a) Structural Steel Shapes
ASTM F 436	(2004) Hardened Steel Washers
ASTM F 959	(2004) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

1.03 MODIFICATIONS TO REFERENCES

AISC 325, AISC 350, AISC 303, AISC 348, and AISC S340, except as modified in this section, shall be considered a part of AISC M018L and AISC M019L and is referred to in this section as AISC 325.

1.04 SUBMITTALS

A. Action Submittals:

1. Provide Shop Drawing details showing:

a. Complete details and schedules for fabrication and shop assembly of members and details of cuts, connections, camber, holes and other pertinent data. Indicate welds by standard AWS symbols and show size, length, and type of each weld.

b. Provide setting or erection Drawings for the installation of anchor bolts and other anchorages or embedded items to be installed by others.

c. Schedules for fabrication procedures.

d. Primer and other coatings.

The Contractor shall check and stamp all submittals for conformance with these Specifications and with the Drawings before submission to the Engineer. In review of Shop Drawing, Engineer shall not be deemed to have conducted structural analyses or detailed review of standard details prepared under fabricator's design responsibility

2. Name and address of manufacturer(s).

3. Product specifications.

4. Manufacturers' testing procedures and standards.

5. Preparation and installation or application instructions, as appropriate.

B. Informational Submittals:

1. Mill Certificates of tests made in accordance with ASTM A6.

2. High–Strength Bolts (Plain Noncoated and Hot–Dip Galvanized):

   a. Certificates of Compliance that products meet chemical and mechanical requirements of standards specified.

   b. Manufacturer's inspection test report results for production lot(s) furnished, to include:

      1) Tensile strength.

      2) Yield strength.

      3) Reduction of area.

      4) Elongation and hardness.

   c. Certified Mill Test Reports for Bolts and Nuts:

      1) Name and address of manufacturer.

      2) Bolts correctly marked.

      3) Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.

3. Direct Tension Indicators (DTIs): Furnish manufacturer's test report meeting requirements of ASTM F959.

4. Tension Control (TC) Bolts: Furnish manufacturer's test report meeting requirements of ASTM A325 and ASTM F1852.

5. Methods proposed to resolve misalignment between anchor bolts and bolt holes in steel members.

6. Welding Materials Procedures, Qualifications, and inspection Report: As specified in Section 05 05 23, Welding.

7. Non-shrink Grout

8. Hot–Dip Galvanizing: Certificate of compliance signed by galvanizer with description of material processed and ASTM standard used for coating.

9. AISC Quality Certification: AISC certificate showing name and address of certified firm, effective date, and category of certification; or, for erectors, documentation of similar project experience to include project name, location, date of completion, and name and phone number of owner's contact person.

1.05 QUALITY ASSURANCE

A. Drawing Requirements:

1. Fabricate structural steel members in accordance with AISC Code of Standard Practice.

2. Design connections not detailed on Drawings under direct supervision of a registered Professional Structural Engineer experienced in design of this Work and licensed in South Carolina.

3. Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326, AISC 316 and AISC 317. Drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols.

B. Mill identification marks in accordance with ASTM A6.

C. AISC Quality Certification for Fabricator: Conventional Steel Structures (Sbd).

D. AISC Quality Certification as Certified Steel Erector (CSE), or documented experience in erection of at least five similar structural steel facilities over the past 10 years in lieu of AISC certification.

E. Welding Qualifications: As specified in Section 050523, Welding.

F. Galvanized Coating Applicator: Company specializing in hot–dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.

B. Storage:

1. Protect structural steel members and packaged materials from corrosion and deterioration.

2. Store in dry area and not in direct contact with ground.

3. Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.

C. Handle materials to avoid distortion or damage to members or supporting structures.

D. Shop fabrication shall be sequenced/scheduled so that delivery will expedite erection, will minimize field handling of materials, and will ensure uninterrupted progress of the work

PART 2 – PRODUCTS

2.01 MATERIALS

A. Channels, Angles and Plates: ASTM A36, unless indicated otherwise.

B. W –Shapes:

1. ASTM A992, Grade 50 unless indicated otherwise on Drawings.

C. Steel Pipe: ASTM A53, Type E or S, Grade B.

D. Round Hollow Structural Sections (HSS): ASTM A500, Grade B (Fy equals 42 ksi).

E. Square and Rectangular Hollow Structural Sections (HSS): ASTM A500, Grade B (Fy equals 46 ksi).

F. For hot–dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for A36 and A572 steels), limit the maximum silicon content to 0.21 percent and the phosphorous content to 0.03 percent.

2.02 FASTENERS

A. Anchor Bolts: As specified in Section 05 50 0, Metal Fabrications.

B. High–Strength Bolts: ASTM A325, bolt type I plain uncoated. Bolt length and thread length shall be as required for the connection type shown, with hardened washers as required.

C. Direct Tension Indicators (DTIs) or Load Indicator Washers:

1. ASTM F959, coating type to match bolt finish.

2. Type A325 or A490, to match bolt type.

3. Manufacturers and Products:

a. TurnaSure LLC, Langhorne, P A; TI's.
b. Applied Bolting Technology Products, Ludlow, VT; DTI's, regular or Squirter type.

D. Tension Control (TC) Bolts:

1. High–strength, ASTM A325 and ASTM F1852.

2. Manufacturers:

a. Lejeune Bolt Company, Bumsville, MN.

b. Nucor Fastener, Saint Joe, IN.

c. T.S. Bolts and Tools, Bristol Machine Co., Walnut, CA.

d. Haydon Bolts, Philadelphia, P A.

e. Vermont Fasteners Manufacturing, Swanton, VT.

E. Nuts: ASTM A563, type to match bolt type and finish.

F. Hardened Steel Flat and Beveled Washers: AS M F436, type to match bolt finish.

G. Welded Shear Studs: As specified in Section 05 00 00, Metal Fabrications.

2.03 ANCILLARY MATERIALS

A. Surface Preparation and Primer: As specified in Section 09 90 00, Painting and Coating.

B. Grout: As specified in Section 03 30 00 Cast-In-Place Concrete.

2.04 FABRICATION

A. General:

1. Fabricate as shown and in accordance with AISC Specification For Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges.

2. Columns shall be full length members without splices, unless shown otherwise or approved by Engineer.

3. Mark and match materials for field assembly.

4. Complete assembly, including bolting and welding of units, before start of finishing operations.

5. Fabricate to agree with field measurements.

B. Connections:

1. Shop Connections: Weld or bolt, as shown.

2. Meet requirements of AISC Manual of Steel Construction tables for bolted double–angle shear connections, unless indicated otherwise.

3. Meet OSHA requirements for one independent bolt at beams framing in to column web connections.

4. Provide oversized holes for anchor bolts in column base plates in accordance with AISC Manual of Steel Construction, unless indicated otherwise.

C. Welded Construction:

1. As specified in Section 05 05 23, Welding.

2. Groove and Butt Joint Welds: as indicated. Where no size is provided, Engineer intends for minimum size for the prequalified weld to be used from AISC Manual of Steel Construction.

D. Interface With Other Work:

1. Holes:

a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.
b. No flame–cut holes will be permitted without prior approval of Engineer.

2. Weld threaded nuts to framing, and other specialty items as shown to receive other Work.

E. Shop Paint Primer:

1. Surface Preparation and painting as specified in Section 09 90 00, Painting and Coating.

2. Do not shop prime the following surface , unless indicated otherwise:

a. Faying surfaces of slip critical bolt d connections.

b. Within 2 inches of field–welded connections.

c. Steel members to be completely encased in reinforced concrete or coated with cementitious fireproofing.

3. Apply shop primer to top flange surfaces of composite steel beams unless indicated otherwise.

F. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143, ASTM A384, and ASTM A385. Avoid fabrication techniques that could cause distortion or embrittlement of steel.

2. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.

3. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.

4. Hot–dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A 23.

5. Hot–dip galvanize ASTM A325 bolts, nuts, washers, and hardware components in accordance with ASTM 153. Oversize holes to allow for zinc alloy growth. Shop assemble bolts, nuts, and washers with special lubricant and test in accordance with ASTM A325 and ASTM A563.

6. Tension–control (TC) bolts, nuts, and washers shall be mechanically zinc coated in accordance with ASTM F1852 and ASTM B695, Class 50.

7. Galvanize components of bolted assemblies separately before assembly.

G. Slip Critical Bolted Connections:

1. Mask faying surfaces of slip critical (SC) bolted connections to be shop painted as specified in Section 09 90 00, Painting and Coating.

2. Roughen galvanized faying surfaces with hand wire brushing.

2.05 SOURCE QUALITY CONTROL

A. Welding:

1. Visually inspect fabrication welds in accordance with AWS D 1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.

2. Repair and retest defective welds as specified in Section 05 05 23, Welding.

B. Hot–Dip Galvanizing:

1. An independent testing agency will be retained by Owner, if necessary.

2. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123 and ASTM A153.

3. Reject and retest nonconforming articles in accordance with ASTM A123 and ASTM A153.

PART 3 – EXECUTION

3.01 ERECTION

A. Meet requirements of AISC Specification for Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges, with exceptions as specified.

B. Install Contractor–designed temporary construction bracing to provide necessary support until components are in place and construction is complete.

C. High–Strength Bolted Connections:

1. Tighten in accordance with AISC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

2. Hardened Washers:

a. Provide at locations required by Washer Requirements section of AISC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts, to include slip critical connections using slotted or oversized holes or ASTM A490 bolts.

b. Use beveled style and extra thickness where required by AISC Specification.

c. Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.

d. Do not substitute DTIs for hardened flat washers required at slotted and oversize holes.

3. For bearing–type connections not fully tensioned (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.

D. Fully Tensioned Bolted Connections:

1. Use DTIs or TC bolts at slip critical (SC) and fully tensioned (FT) bearing–type connections.

2. DTIs:

a. Position within bolted assembly in accordance with ASTM F959.

b. Install bolts, with DTIs plus hardened washers as required, in all holes of an assembly and tighten until plies are in firm contact and fasteners are uniformly snug tight.

3. Final tighten bolts, beginning at most rigid part of bolted connection and progressing toward free edges, until final twist–off of TC bolts or until DTIs have been compressed to an average gap equal to or less than shown in Table 2, ASTM F959.

E. Welded Connections:

1. As specified previously herein.

3.02 ANCHOR BOLTS

A. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in–place work.

B. Provide templates and other devices for presetting bolts and other anchors to accurate locations.

C. Projection of anchor bolts beyond face of concrete and threaded length shall be adequate to allow for full engagement of all threads of hold–down nuts, adjustment of leveling nuts, washer thicknesses, and construction tolerances, unless indicated otherwise.

D. Placement Tolerances:

1. As required by AISC Code of Standard Practice for Steel Buildings and Bridges, unless indicated otherwise.

2. Embedded anchor bolts shall not vary from the dimensions as shown on Drawings by more than the following:

a. Center to center of any two bolts within an anchor group: 1/8 inch

b. Center to center of adjacent anchor bolt groups: 1/4 inch.

c. Variation from perpendicular to theoretical bearing surface: 1:50.

3.03 SETTING BASES AND BEARING PLATES

A. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.

B. Clean bottom surface of base and bearing plates.

C. Set loose and attached base plates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices. Use leveling *plates* where indicated.

D. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout. Weld plate washers to base plates where indicated.

E. Grout Under Baseplates, prior to placing loads on structure.

1. Center to center of any two bolts within an anchor group: 1/8 inch.

2. Center to center of adjacent anchor bolt groups: 1/4 inch.

3. Variation from perpendicular to theoretical bearing surface: 1:50.

3.04 FIELD ASSEMBLY

A. Set structural frames accurately to lines and elevations shown.

B. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.

C. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.

D. Level and plumb individual members of structure within tolerances shown in AISC Code of Standard Practice for Steel Buildings and Bridges.

E. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.

F. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

G. Provide additional field connection material as required by AISC Code of Standard Practice for Steel Buildings and Bridges.

H. Splice members only where indicated and accepted on shop drawings.

3.05 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, immediately notify Engineer for approval of one of the following: methods of correction:

1. Ream holes that must be enlarged to admit bolts and use oversized bolts.

2. Plug weld misaligned holes and redrill holes to admit standard size bolts.

3. Drill additional holes in connection, conforming to AISC Standards for bolt spacing and end and edge distances, and add additional bolts.

4. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.

B. Do not enlarge incorrectly sized or misaligned roles in members by burning or by use of drift pins.

3.06 MISFITS AT ANCHOR BOLTS

A. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved submittal.

B. Do not flame cut to enlarge holes without prior approval of Engineer.

3.07 GAS CUTTING

A. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.

B. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by Engineer.

C. Finish flame–cut sections equivalent to sheared and punched appearance.

3.08 REPAIR AND CLEANING

A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop primer.

B. Remove and grind smooth tack welds, fit–up–lugs, and weld runoff tabs.

C. Remove weld back–up bars and grind smooth where indicated on Drawings.

D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09 90 00, Painting and Coating.

3.09 REPAIR OF DAMAGED HOT–DIP GALVANIZED COATING

A. Conform to ASTM A 780.

B. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780.

C. For flame cut or welded areas, use zinc–based solder, or zinc sticks, conforming to ASTM A780.

D. Use magnetic gauge to determine that thickness is equal to or greater than base galvanized coating.

3.10 FIELD QUALITY CONTROL

A. High–Strength Bolted Connections:

1. An independent testing agency will be retained by Owner to perform the following inspection and testing in accordance with the AISC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts:

a. Marking identification and conformance to ASTM standards.

b. Alignment of bolt holes.

c. Placement, type, and thickness of hardened washers.

d. Tightening of bolts.

2. Bearing–Type Connections Not Fully Tensioned (N, X): Snug tight condition with plies of joint in firm contact.

3. Fully Tensioned (FT) Bearing and Slip Critical (SC) Connections:

a. Conduct preinstallation test.

b. Monitor installation and tightening of DTIs or TC bolts.

c. Monitor condition of faying surfaces for slip critical connections.

4. Preinstallation Test:

a. Conduct jobsite test prior to start of work using a bolt tension measuring device.

b. Select representative sample of not less than three bolts of each diameter, length, and grade.

c. Include DTIs and flat hardened washers as required to match actual connection assembly.

d. Conduct test in accordance with Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

5. Nondestructive Testing (NDT) Report: Prepare and submit a written NDT report identifying location of inspected bolted connections and summary of corrections as required to meet code acceptance criteria.

6. Defective Connections: Correct and reinspect defective and improperly tightened high–strength bolted connections. Retest fully tensioned bolts as necessary to demonstrate compliance of completed work.

B. Welded Connections:

1. Visually inspect field welds in accordance with AWS D 1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.

2. Repair and retest defective welds as specified in Section 05 05 23, Welding.

END OF SECTION

SECTION 05 31 00

STEEL DECKING

PART 1 – GENERAL

1.01 REFERENCES

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

1. American Iron and Steel Institute (AISI): Specifications for the Design of Cold Formed Steel Structural Members.

2. American Welding Society (AWS): D1.3, Structural Welding Code Sheet Steel.

3. ASTM International (ASTM):

   a. A653, Standard Specification for Steel Sheet, Zinc–Coated (Galvanized) or Zinc–Iron Alloy–Coated (Galvannealed) by the Hot–Dip Process.

   b. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot–Dip Galvanized Coatings.

   c. A924, Standard Specification for General Requirements for Steel Sheet, Metallic–Coated by the Hot–Dip Process.

4. Steel Deck Institute (SDI):

   a. Design Manual for Composite Decks, Form Decks, and Roof Decks.

   b. Diaphragm Design Manual.

5. Factory Mutual (FM):

   a. Factory Mutual Approval Guide.

   b. FM Research Corporation (FMRC): Approval Requirements for Steel Roof Deck Construction.

6. Underwriters Laboratories, Inc. (UL): Fire Resistance Directory.

1.02 SUBMITTALS

A. Action Submittals:

1. Plan view layout of decking showing type and section properties of deck panels, reinforcing channels, pans, special jointing, and accessories.

2. Location of openings, deck laps, and deck attachment details.

B. Informational Submittals:

1. Decking manufacturer's installation requirements.

2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.

3. Operation manuals for mechanical fastener installation tools.

4. Manufacturer's Certificate of Compliance to state product conformance with design requirements.

1.03 QUALITY ASSURANCE

A. General: For metal decking section properties, meet requirements of AISI Specifications for Design of Cold–Formed Steel Structural Members.

B. FM Requirements:

1. Steel Roof Deck: Listed in Factory Mutual "Approval Guide" for Class 1 fire rating and Class 1–120 wind uplift rating.

2. Mechanical Fasteners: Packing containers shall show name of manufacturer and product and FMRC approval mark.

C. Qualifications for Field Welding: As specified in Section 05 05 23, Welding.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store deck bundles on platforms or pallets, with one end elevated to provide drainage.

C. Protect bundles against condensation with a ventilated waterproof covering.

D. Stack bundles so there is no danger of tipping, sliding, rolling, shifting, or material damage.

PART 2 – PRODUCTS

2.01 METAL DECKING

A. Materials and Finishes:

1. Galvanized Deck:

a. Sheet steel for galvanized deck and accessories shall conform to ASTM A653 Structural Quality Grade 33 or higher.

b. Galvanizing shall conform to ASTM A924 with coating class of G90 as defined in ASTM A653.

B. Manufacturers:

1. Vulcraft Division of Nucor Co. Model 2VLI, 20 Gage.

2. Approved equal.

C. Welding Materials: AWS D1.1

2.02 ACCESSORIES

A. Provide pour stops, column closures, end closures, cover plates, girder fillers, ridge and valley plates, finish strips, reinforcing channels, and other accessories as required for complete installation.

B. Accessories shall be minimum 22–gauge, except edge forms shall be sized as required by the deck manufacturer, unless shown otherwise on the Drawings.

2.03 MECHANICAL FASTENERS

A. Self–Drilling Screws:

1. Galvanized, hardened, self–drilling, self–tapping screws with hexagonal washer head.

2. Manufacturers and Products:

a. ITW Buildex, Itasca, IL;

b. Hilti, Inc., Tulsa, OK;

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.

3.02 INSTALLATION

A. Install deck panels and accessories according to Steel Deck Institute specifications and recommendations, SDI Manual of Construction with Steel Deck, and in accordance with the placement plans and requirements of this Section.

B. Locate deck bundles to prevent overloading of support framing members.

C. Install at right angles to supporting members in a three span minimum lay–up, unless shown otherwise, and in accordance with Specification and manufacturer's installation recommendation.

D. Bearing: 1–1/2 inches, minimum.

E. Endlaps: Minimum of 2 inches and located over supports.

F. Do not stretch sidelaps.

G. Cut and neatly fit deck and accessories at skew conditions, around openings, and at other work projecting through or adjacent to the decking

H. Closure Plates:

1. Install closure and cover plate accessories as recommended by the metal deck manufacturer, unless shown otherwise on the Drawings.

2. Floor Deck and Form Deck Closures:

a. Fasten column closures, cell closures, and zee closures to deck to provide tight fitting closures at open ends of ribs and sides of decking.

b. Fasten cell closures at changes of direction of deck units unless otherwise indicated.

I. Holes and Openings

1. Do not cut unscheduled openings through the deck without the approval of the Engineer. Reinforce openings as directed.

2. Cut and fit around roof openings and other work projecting through or adjacent to decking.

3. Locate holes and openings to clear structural framing and bracing members.

4. Reinforcement around openings:

a. Roof Deck: For hole sizes of at least 6 inches across, but not more than 12 inches across in roof deck, reinforce with 0.0474–inch design thickness steel plate, painted, or galvanized to match deck coating. Extend plate at least 12 inches beyond opening in all directions and attach to top of roof deck with No. 10 self–drilling screws at 6–inch spacing and at all corners. For openings larger than 12 inches across, reinforce roof deck with framing as shown on Drawings.

J. Protect deck areas from heavy concentrated loads or wheel traffic with planking or other approved means. Do not impose construction loads that exceed the load capacity of the deck.

K. Install temporary shoring, if required, to meet strength and deflection limitations, before placing any concrete topping on deck panels.

L. Completed Deck: Free from buckles and irregularities, and in accordance with FM and UL requirements.

3.03 DECK ATTACHMENT

A. Fasten panels as shown in the following schedule:

Steel Deck Attachment Schedule							
		At Perpendicular Supports		At Parallel Supports		At Sidelaps	
Type	Depth (in)	Type	Spacing	Type	Spacing (in)	Type	Spacing
Floor Deck	2 + 4	5/8” dia. puddle welds	12” o.c.	5/8” dia. puddle welds	24” max	Weld per Mfr	24” max

B. Welded Connections: Weld deck sidelaps, attachment to framing, and accessories in accordance with AWS D1.3 and as specified in Section 05 05 23, Welding.

C. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating with two coats of cold galvanizing compound which imparts cathodic action against corrosion. Surface preparation and application shall be in accordance with the manufacturer's instructions.

D. Mechanical Fasteners:

1. Self–Drilling Screws:
   a. Install screws in accordance with manufacturer's written instructions and with special installation tool. Do not over–torque.

   b. Remove and redrive screws at sidelaps where upper sheet is not drawn tightly against lower sheet.

3.04 TOUCHUP PAINTING

A. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating with two coats of cold galvanizing compound which imparts cathodic action against corrosion. Surface preparation and application shall be in accordance with the manufacturer's instructions.

B. Immediately following erection, remove unused deck edge trimmings, screws, fasteners, welding washers, butt ends of welding rods, and debris from completed installation.

C. Clean field welds, bolted connections, rust spots, and abraded areas.

D. Repair any damaged galvanized surfaces with zinc–rich spray paint in accordance with ASTM A 780; color to match galvanized deck.

E. Use magnetic gauge to determine that thickness of repair is equal to or greater than base painted or galvanized coating.

3.05 FIELD QUALITY CONTROL

A. An independent testing agency will be retained by Owner to perform following inspections.

1. Welded Connections: Visually inspect in accordance with AWS D1.3, Section 7, and as specified in Section 05 05 23, Welding.

2. Mechanical Fasteners: Visually inspect, in accordance with manufacturer's instructions, for each type of fastener.

B. Repair or replace defective welds and fasteners.

END OF SECTION

SECTION 05 41 00

COLD-FORMED STEEL FRAMING

PART 1 – GENERAL

1.01 SUMMARY

1. This section applies to cold-formed metal trusses.

2. Relevant specification sections include 09 22 16, Non-Structural Metal Framing, applicable to interior non-loadbearing metal stud wall framing.

1.02 SUBMITTALS

A. Product Data: Truss Component Manufacturer's material certifications and descriptive literature for each item of cold-formed metal framing and each accessory specified in this section.

B. Shop Drawings: Truss fabricator's drawings and details that indicate the following:

1. special components and installations not fully detailed in product data
2. the number, types, location, and spacings of trusses and other framing members
3. details of truss loading, reactions, uplifts, support locations, material sizes and gauges, permanent truss web bracing, and splices as required for a complete installation

C. Truss Component Manufacturer's Instructions: Printed installation instructions for each item of cold-formed metal framing and each accessory specified in this section.

D. Design Data: Results of design analysis, bearing the seal and signature of a professional engineer registered in the State in which project is located.

E. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.

1.03 QUALITY ASSURANCE

A. General: For member section properties, meet requirements of AISI, Specification for the Design of Cold–Formed Steel Structural Members and Design Guide for Cold–Formed Steel Trusses.

B. Qualifications for Welding: As specified in Section 05 05 23, Welding.

C. Pre-installation Meeting: to be held on site prior to commencement of construction activities of this section to include installer(s) of products in this section, general contractor, engineer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Handle and lift shop assembled units in accordance with Truss Component Manufacturer's recommendations to prevent damage or distortion.

B. Deliver to Site in bundles marked with name of manufacturer, section type, thickness, grade of material, and length.

C. Store bundles on wood blocking, flat and off ground, to keep clean and to prevent any damage or permanent distortion. Adhere to other recommendations from Truss Component Manufacturer to prevent damage, distortion and moisture buildup.

1.05 DESIGN REQUIREMENTS

A. Design loads shall be as indicated on the drawings.

B. Design framing systems to withstand design loads without vertical deflections greater than 1/240 of the span.

C. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 degrees F.

D. Design framing systems to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings.

PART 2 – PRODUCTS

2.01 GENERAL

A. Truss system, with framing components and accessories, shall provide a complete horizontal framing system, ready for deck installation, meeting specified Design Requirements.

B. Dimensions and Properties: Calculate section properties in accordance with AISI Cold–Formed Steel Design Manual.

2.02 MANUFACTURERS

A. Choose from the following:

1. AMS, Los Angeles, CA; Angeles Metal Systems.

2. Clark Steel, Middleton, OH; Steel Framing Systems.

3. Dale Industries; Dearborn, MI; Dale/Incor Steel Framing.

4. Dietrich Industries, Pittsburgh, P A; Lightgauge Metal Framing Products.

5. Other approved suppliers may be considered upon request, prior to submittal of bids and contract award.

1.03 MATERIALS

A. Truss chord and web components shall have rolled or closed edges.

B. Load Bearing Members: Mechanical properties of components shall be determined by testing conforming to ASTMA 370 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products. Members shall be cold-formed to indicated sizes, profiles, and thickness of steel conforming to ASTMA 653, minimum G60 coating, and ASTM A500 as follows:

1. Chord materials - Minimum yield strength 55,000 KSI
2. Web materials - Minimum yield strength 45,000 KSI.
3. Shapes: Indicated on shop drawings.
4. Size: Indicated on shop drawings.
5. Gauge: Indicated on shop drawings.

C. Fasteners Used in Fabricating Trusses: All web to chord connections shall be made with the appropriate screw fastener as recommended by the Truss Component Manufacturer. Each screw shall bear the stamp of the Truss Component Manufacturer for ready identification. Alternative fastening methods, such as welding, are not acceptable.

D. Accessories shall be from same manufacturer as trusses.

2.04 MECHANICAL FASTENERS

A. Self–Drilling Screws:

1. Self–drilling, self–tapping screws with hexagonal washer head and corrosion–resistant finish.

2. Manufacturers and Products:

a. ITW Buildex, Itasca, IL; ICH Traxx Self–Drilling Fasteners with Climaseal Coating and Autotraxx Standup Installation Tool.

b. Hilti, Inc., Tulsa, OK; Kwik–Pro RWH Self–Drilling Screws with Kwik–Cote Treatment and Kwik–Tapper Screwdriver.

B. Powder–Driven Fasteners:

1. Knurled shank, minimum l/2–inch diameter steel washer, corrosion–resistant coating.

2. Pin diameter and length to suit deck type and flange thickness of steel support member.

3. Manufacturers and Products:

a. ITW Buildex, Itasca, IL; Buildex BXI4 pins with yellow dichromate galvanizing and BX900 Installation Tool.

b. Hilti, Inc., Tulsa, OK; ENP–series fasteners with electroplated zinc coating and DX–750 Installation Tool.

2.05 FABRICATION

A. Shop fabricate from cold formed steel components in accordance with shop drawings, using jigging systems to ensure consistent component placement and alignment of components, and to maintain specified tolerances as shown herein.

B. Field fabrication of trusses is strictly prohibited unless performed by authorized fabricator using the fabricator's shop assemblers and proper jigging systems. Request for this must be sent to Engineer with fabricator documentation.

C. Shop fabrication of other cold formed steel framing components into assemblies prior to erection is permitted; fabricate assemblies in accordance with shop drawings.

2.06 TOLERANCES

A. Material Tolerances: Steel for cold-formed chord components:

1. Nominal 22 ga. members: Minimum bare metal thickness: 0.0284 inch, Maximum design thickness: 0.0299 inch.
2. Nominal 20 ga. members: Minimum bare metal thickness: 0.0329 inch, Maximum design thickness: 0.0346 inch.
3. Nominal 18 ga. members: Minimum bare metal thickness: 0.0428 inch, Maximum design thickness: 0.0451 inch.
4. Nominal 16 ga. members: Minimum bare metal thickness: 0.0538 inch, Maximum design thickness: 0.0566 inch.

B. Material Tolerances: Steel for cold-formed web components

1. Nominal 20 ga. members: Minimum bare metal thickness: 0.033 inch, Maximum design thickness: 0.035 inch.
2. Nominal 18 ga. members: Minimum bare metal thickness: 0.047 inch, Maximum design thickness: 0.049 inch.
3. Nominal 16 ga. members: Minimum bare metal thickness: 0.063 inch, Maximum design thickness: 0.065 inch.

C. Materials Tolerances: Truss Assemblies: Fabricate to tolerances of maximum variation from plumb, level, or true to line as indicated below:

1. Trusses up to 30 ft long = max 1/2 in. variation from design length.
2. Trusses over 30 ft. long = max 3/4 in. variation from design length.
3. Trusses up to 5 ft. high = max 1/4 in. variation from design height.

4. Trusses over 5 ft. high = max 1/2 in. variation from design height.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Inspect all fabricated assemblies and repair any damage.

B. Examine bearing support surfaces for compliance with requirements for installation tolerances and other conditions affecting performance of metal framing systems.

C. Provide smooth level bearing surfaces.

D. Clean all member and bearing surfaces that will be in contact after assembly.

3.02 INSTALLATION

A. General:

1. Install framing systems as indicated on Drawings, complete and in accordance with manufacturer's recommendations.

2. Provide temporary bracing for support of all construction loads until framing system is installed complete with sheathing or decking.

3. Install framing in true line, plumb, level, and in proper alignment.

4. Cut ends of framing members with saw or shear to bear uniformly against abutting members. Flame cutting is not permitted.

5. All structural framing members shall be full–length without splices, unless indicated otherwise.

6. Fasten members together in accordance with AISI, Cold–Formed Steel Design Manual, Part N, Connections. Wire tying is not permitted.

B. Metal Trusses:

1. Install metal trusses in accordance with Truss Component Manufacturer's instructions and the Truss Fabricator's shop drawing submittal. Place components at spacings indicated on the Truss Fabricator's shop drawings. Install truss installation (erection) bracing. Truss installation (erection) bracing shall hold trusses straight and plumb and in safe condition until decking and permanent truss bracing has been fastened, forming a structurally sound framing system. All sub-contractors shall employ proper construction procedures to insure adequate distribution of temporary construction loads so that the carrying capacity of any single truss or group of trusses is not exceeded.

2. Install required roof and system permanent bracing and bridging as indicated by the drawings and notes of the Architect or Engineer. See the Truss Fabricator's shop drawings for any additional bracing requirements. All truss installation (erection) bracing and permanent bracing and bridging shall be installed before the application of any loads.

3. The field removal, cutting or alteration of any truss chord, web or bracing members is not allowed without prior written approval of the Engineer and the Truss Designer.

4. Damaged chords, webs and complete trusses shall be repaired or replaced as directed and approved in writing by the Engineer and the Truss Designer prior to installation or application of the repair or replacement.

5. Install field fasteners as identified on drawings and in accordance with Manufacturer's recommendations.

6. Tolerances:

   a. Variation from Level or Specified Plane: Maximum 1/8 inch in 10 feet.

   b. Variation from Specified Position: Maximum 1/4 inch.

3.03 FIELD QUALITY CONTROL

A. An independent testing agency will be retained by Owner to inspect field connections and welds.

1. Mechanical Fasteners: Visually inspect in accordance with manufacturer's instructions, for each type of fastener.

2. Welded connections performed during fabrication shall be visually inspected.

B. Repair or replace defective welds and/or fasteners.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1- GENERAL

1.01 CLASSIFICATION OF ENVIRONMENTS

A. See Paragraph 1.03 of Section 01 00 01, General Requirements for additional information.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Metal fabrications, including welding and fastener information.
   b. Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

2. Samples: Color samples of abrasive stair nosings.

B. Informational Submittals:

1. Concrete and Masonry Drilled Anchors:
   a. Manufacturer's product description and installation procedures.
   b. Current test data or ICC Evaluation Report.
   c. Adhesive Anchor Installer Certification.

2. U–Channel Concrete Inserts:
   a. Manufacturer's product description.
   b. Allowable load tables.

3. Ladders: Certification of load and fatigue tests.

4. Passivation method for stainless steel members.

5. Hot–Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.03 QUALITY ASSURANCE

A. Qualifications:

I. Adhesive Anchor Installers: Trained and certified by manufacturer.

2. Galvanized Coating Applicator: Company specializing in hot–dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble items specified herein. Assemblies that due to necessity have to be shipped unassembled shall be packaged and tagged in manner that will protect materials from damage and will facilitate identification and field assembly.

B. Package stainless steel items in a manner to provide protection from carbon impregnation.

C. Protect painted coatings and hot–dip galvanized finishes from damage due to metal banding and rough handling. Use padded slings and straps.

D. Store fabricated items in dry area, not in direct contact with ground.

1.05 GUARANTEE–OWNER AS BENEFICIARY

A. Provide manufacturer's guarantee or warranty, with Owner named as beneficiary, in writing. Guarantee shall provide for correction of Work specified in this Section found defective during period of 2 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following extra materials:

Item	Quantity
Neoprene Gasket	Two for each location requiring neoprene gaskets.
Four–inch wide by 50–foot long neoprene gasket material	One roll for each location requiring neoprene gaskets.
Neoprene Gasket Adhesive each	One (manufacturer's recommended) for location requiring neoprene gaskets.

B. Delivery: In accordance with Section 01 00 01, General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. For hot–dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for

A36 steel), limit the maximum silicon content to 0.21 percent and the phosphorous content to 0.03 percent.

B. Unless otherwise indicated, meet the following requirements:

Item	**ASTM Reference**
Stainless Steel:	
Bars and Angles	A276, AISI Type 304 or 316 (304L or 316L for welded connections)
Shapes	A276, AISI Type 304 or 316 (304L or 316L for welded connections)
Steel Sheet, and Strip	*A240*/A240M, AISI Type 304 or 316 (304L or 316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 304 or 316, Condition CW
Nuts	F594, AISI Type 304 or 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High–Strength nuts	A325, Type 1 bolts, with A563
Anchor Bolts and Rods	FI554, Grade 55, with weldability supplement S 1.
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	AI93/AI93M, Grade B7
Nuts	AI94/AI94M, Grade 2H
Plate	A283/A283M, Grade 2D
Welded Anchor Studs	A108, Grades C–1010 through C–1020
Aluminum Plates and Structural Shapes	B209 and B308/B308M, Alloy 6061–T6
Aluminum Bolts and Nuts	F468, Alloy 2024–T4
Cast Iron	A48, Class 35

C. Bolts, Washers, and Nuts: Use stainless steel, hot–dip galvanized steel, zinc–plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast–In–Place Anchor Bolts:

1. Headed type, unless otherwise shown on Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self–threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High density polyethylene.
   d. Manufacturer: Sinco Products, Inc., Middletown, CT, (800) 243–6753.
2. Fabricated Steel: ASTM A36/A36M.

2.03 CONCRETE AND MASONRY DRILLED ANCHORS

A. General:

1. AISI Type 304 or 316 stainless, hot–dip galvanized, or zinc–plated steel, as shown in Fastener Schedule at end of this section.

2. Current evaluation and acceptance reports by ICC or other similar code organization.

B. Wedge Anchors:

1. Manufacturers and Products:

   a. ITW Ramset/Red Head, Addison, JL; Trubolt Wedge Anchor.
   b. Hilti, Inc., Tulsa, OK; Kwik–Bolt–3 (KB–3) Anchor.
   c. Powers Fasteners, New Rochelle, NY; Power–Stud Anchor.
   d. Simpson Strong–Tie Co., Inc., Pleasanton, CA; Wedge–All Anchor.
   e. Wej–It Corp., Tulsa, OK; ANKR–tite Wedge Anchor.
   f. Adhesives Technology, Pompano Beach, FL; Kingpin Wedge Anchor.
   g. Unitex, Kansas City, MO; Pro–Poxy 300 and Pro–Poxy 300 Fast Epoxy Adhesive Anchors.

C. Expansion Anchors:

1. Self–drilling anchors, snap–off or flush type, zinc–plated.

2. Non–drilling Anchors: Flush type for use with zinc–plated or stainless steel bolt, or stud type with projecting threaded stud.
3. Manufacturers and Products:
   a. ITW Ramset/Red Head, Addison, JL; Multi–Set II Drop–In and Self Drill Anchor.
   b. Hilti, Inc., Tulsa, OK; Hilti HDI Drop–In Anchor.
   c. Powers Fasteners, New Rochelle, NY; Steel Drop–In Anchor.
   d. Simpson Strong–Tie Co., Inc., Pleasanton, CA; Drop–In Anchor.

D. Undercut Anchors:

1. Manufacturers and Products:
   a. USP Structural Connectors; DUC Undercut Anchor.
   b. Hilti, Inc., Tulsa OK; HDA Undercut Anchor.

E. Sleeve Anchors:

1. Manufacturers and Products:

a. ITW Ramset/Red Head, Addison, Il.,; Dynabolt Hex Nut Sleeve Anchor.
b. Powers Fasteners, New Rochelle, NY; Hex Head Power–Bolt Anchor.
c. Simpson Strong–Tie Co., Inc., Pleasanton, CA; Sleeve–All Hex Head Anchor.
d. Wej–It Corp., Tulsa, OK; Wej–It Sleeve Anchor.
e. Hilti, Inc., Tulsa, OK; HSL–3 Heavy Duty Sleeve Anchor.

F. Adhesive Anchors:

1. Threaded Rod:

   a. ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.
   b. Length as required, to provide minimum depth of embedment.
   c. Clean and free of grease, oil, or other deleterious material.
   d. For hollow–unit masonry, provide galvanized or stainless steel wire cloth screen tube to fit threaded rod.

2. Adhesive:

   a. Two–component, designed to be used in adverse freeze/thaw environments, with gray color after mixing.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
   c. Nonsag, with selected viscosity base on installation temperature and overhead application where applicable.
   d. Adhesive anchoring system shall be certified to meet AC308.

3. Packaging and Storage:

   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. Store adhesive cartridges on pallets or shelving in covered storage area, in accordance with manufacturer's written instructions.

c. Cartridge Markings: Include manufacturer's name, product name, material type, batch or serial number, and adhesive expiration date.

d. Dispose of cartridges if shelf life has expired.

4. Manufacturers and Products:

a. Hilti, Inc., Tulsa, OK; HIT RE 500, HIT HY 20 and HY 200.

G. Adhesive Threaded Inserts:

1. Stainless steel, internally threaded insert.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS–R Insert with HIT HY 200 adhesive.

2.04 WELDED ANCHOR STUDS

A. Headed anchor studs (HAS), threaded anchor studs (TAS), or deformed bar anchors (DBA), as indicated on Drawings.

1. Carbon Steel: ASTM AI08, Standard Quality Grades 1010 through 1020, inclusive either semi–killed or killed aluminum or silicon dioxidation, unless indicated otherwise.

B. Manufacturers:

1. Nelson Stud Welding, FabriSteel Co., Elyria, OH.
2. Stud Welding Associates, Inc., Elyria, OH.

2.05 PIPE SLEEVES

A. As specified in Division 40 Specifications.

2.06 STEEL LINTELS AND SHELF ANGLES

A. In accordance with shapes and designations shown in Section 05 12 00 Structural Steel Framing.

2.07 ALUMINUM SUPPORT FRAMES FOR FLOOR PLATE AND GRATING

A. Aluminum support frames and connections to be installed in concrete shall be designed and provided by the fabricator.

B. Protective coatings shall be applied to aluminum components as required by the fabricator.

2.08 FABRICATED UNITS

A. Valve Operator Access Box: Cast iron, 8 inches by 4 inches, as manufactured by Zurn; No. ZN–1930–K.

B. Wire Mesh Screen:

1. Fabricate frame of aluminum shapes and flat bar stock.
2. Wire Mesh: Woven of 14–gauge aluminum wire, three openings per inch, stretched taut over frame before bolts are tightened down.

2.09 CASTINGS

A. Meter Box Manhole: Nonslip surface and handle, as manufactured by Olympic Foundry Co.; 5823B.

B. Floor Boxes:

1. Cast iron, except as otherwise shown.
2. Depth: Equal to slab thickness where installed.
3. Diameter: As shown.
4. Manufacturers and Products:

a. Neenah Foundry, Neenah, WI; R 7506.
b. Mueller, Decatur, IL; No. A–27010.
c. Olympic Foundry Co., Seattle, W A; No. 5680.

2.10 ACCESSORIES

A. Anti–seizing Lubricant for Stainless Steel Threaded Connections:

1. Suitable for potable water supply.
2. Resists washout.
3. Manufacturers and Products:

a. Bostik, Middleton, MA; Neverseez.
b. Saf–T–Eze Div., STL Corp., Lombard, IL; Anti–Seize.

B. Neoprene Gasket:

1. ASTM D1056, 2C1, soft, closed–cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on Drawings.
2. Thickness: Minimum *1/4* inch.
3. Furnish without skin coat.
4. Manufacturer and Product: Rubatex Corporation, Bedford, V A; Rubatex No. *RA11–N.*

2.11 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well–defined lines.

2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be hot–dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures –Allowable Stress Design.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS Dl.l, Section 5.
4. Aluminum: Meet requirements of AWS D 1.2.
5. Stainless Steel: Meet requirements of AWS D1.6.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D 1.1, Section 7, and manufacturer's instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust–inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143, ASTM A384, and ASTM A385. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and

coatings not removable by normal chemical cleaning process in the galvanizing operation.

5. Hot–dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM AI23/A123M.
6. Hot–dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM AI53/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanized steel sheets in accordance with ASTM A653.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

F. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for use in contact with sewage. Cover full bearing surfaces.

G. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

H. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.12 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct any deficiencies.

1. Steel: AWS D 1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D 1.2.
3. Stainless Steel: AWS D1.6.

B. Hot–Dip Galvanizing:

1. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123/A123M and ASTM AI53/A153M.
2. Reject and retest nonconforming articles in accordance with ASTM A123/A123M and ASTM AI53/A153M.

PART 3 - EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb or level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer's recommendations.
4. Obtain Contractor approval prior to field cutting steel members or making adjustments not scheduled.

B. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.

C. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide a center flange for water stoppage on sleeves in exterior or water–bearing walls.
4. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves.

D. Steel Lintels and Shelf Angles: Provide as required for support of masonry and other construction not attached to structural steel framing, unless otherwise shown on Drawings.

3.02 CAST–IN–PLACE ANCHOR BOLTS

A. Accurately locate and hold anchor bolts in place with templates at the time concrete is placed.

B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: l/2–inch diameter by 12 inches long, unless otherwise shown.

3.03 CONCRETE AND MASONRY DRILLED ANCHORS

A. Begin installation only after concrete or masonry to receive anchors has attained design strength.

B. Install in accordance with manufacturer's instructions.

C. Provide minimum embedment, edge distance, and spacing as indicated on the Drawings.

D. Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air.

E. For undercut anchors, use special undercutting drill bit and rotary hammer drill and apply final torque as recommended by anchor manufacturer.

F. When embedded steel or rebar is encountered in the drill path, slant drill to clear obstruction. If drill must be slanted more than 10 degrees to clear obstruction,

notify Contractor for direction on how to proceed.

G. Adhesive Anchors:

1. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F.
2. Remove any standing water from hole with oil–free compressed air. Inside surface of hole shall be dry where required by manufacturer's instructions.
3. For hollow–unit masonry, install screen tube in accordance with manufacturer's instructions.
4. Do not disturb anchor during recommended curing time.
5. Do not exceed maximum torque as specified in manufacturer's instructions.

3.04 U–CHANNEL CONCRETE INSERTS

A. Provide as indicated for pipe supports and where otherwise shown on Drawings.

B. Except for interior dry areas, use plastic clips or similar dielectric material to isolate channel anchors from concrete reinforcing steel.

3.05 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

1. Coat surfaces of aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified by fabricator/manufacturer.
2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full–face neoprene insulation gasket, 3/32–inch minimum thickness and 70–durometer hardness.

C. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.06 PAINTING AND REPAIR OF GALVANIZED STEEL

A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.

B. Repair of Damaged Hot–Dip Galvanized Coating:

1. Conform to ASTM A 780.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780.
3. For flame cut or welded areas, use zinc–based solder, or zinc sticks, conforming to ASTM A780.
4. Use magnetic gauge to determine that thickness is equal to or greater than the base galvanized coating.

3.07 FIELD QUALITY CONTROL

A. Welded Anchor Studs:

1. At start of each production period, Subcontractor shall perform the following test to determine proper generator, control unit, and stud welding gun settings, in accordance with AWS D 1.1, Chapter 7:

    a. Weld two test studs and visually inspect for full 360–degree flash.
    b. Bend test studs 30 degrees from vertical for headed anchor studs (HAS). Torque test threaded anchor studs (TAS) studs per AWS D1.1, Section 7.6.6.2.
    c. Test studs will be acceptable if there is no failure of welds.
    d. If weld fails, repeat test until two consecutive test studs test to be satisfactory.

2. During production, if visual inspection reveals that weld does not exhibit full 360–degree flash or that stud has been repaired by welding, Subcontractor shall perform the following test in accordance with AWS D1.1, Chapter 7:

    a. HAS studs, bend stud approximately 15 degrees from vertical, away from missing portion of flash. For TAS studs, torque test per AWS D1.1, Section 7.6.6.2.
    b. Studs meeting this test without exhibiting cracks in weld will be considered acceptable and left in bent position.
    c. Replace studs failing test.

3.08 MANUFACTURER'S SERVICES

A. Adhesive Anchors: Conduct site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify Contractor of time and place for sessions.

3.09 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications, and Castings		
Interior Dry Areas	Hot–dip galvanized steel headed anchor bolts, unless indicated otherwise.	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts.	See Section 09 90 00 – Painting and Coating
Submerged and Corrosive Areas	Stainless Steel headed anchor bolts	See Section 09 90 00 – Painting and Coating
Service Use and Location	**Product**	**Remarks**
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	See Section 09 90 00 – Painting and Coating
3. Drilled Anchors for Metal Components to Cast–in–Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment.		
Interior Dry areas	Zinc – plated or stainless steel wedge or expansion anchors	Use stainless steel undercut anchors or overhead and ceiling installations.
Submerged, Exterior, Interior Wet, and Corrosive Areas Adhesive stainless steel anchors	Adhesive stainless steel anchors	Use stainless steel undercut anchors or overhead and ceiling installations.
4. Anchors in Grout – Filled Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Hot–Dip galvanized steel anchor bolts, zinc–plated or stainless steel sleeve anchors, or stainless steel adhesive anchors	
5. Anchors in Hollow Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Zinc–plated or stainless steel sleeve anchors or stainless steel adhesive anchors with screen tube.	
6. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High strength steel bolted connections	Use hot–dipped galvanized high–strength bolted connections for galvanized steel framing members

7. Connections for Steel Fabrications and Wood Components		
Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections	

B. Anti–seizing Lubricant: Use on all stainless steel threads.

C. Do not use adhesive anchors to support fire–resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 05 51 00

METAL STAIRS

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. This Section includes the following:

1. Preassembled steel stairs with concrete-filled treads.

B. Related Sections:

1. Section 055213 "Pipe and Tube Railings" for pipe and tube railings.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft..
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

1.4 SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.

2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation and legally authorized to practice in South Carolina.

C. Welding certificates.

D. Qualification Data: For professional engineer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Preassembled Stairs: Commercial class.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.6 COORDINATION

A. Coordinate installation of anchorages for metal stairs. 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 locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).

C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

D. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.

E. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs.

D. Machine Screws: ASME B18.6.3.

E. Lag Bolts: ASME B18.2.1.

F. Plain Washers: Round, ASME B18.22.1.

G. Lock Washers: Helical, spring type, ASME B18.21.1.

H. 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. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations: Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding, unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.
3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

F. Weld connections 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. Weld exposed corners and seams continuously, unless otherwise indicated.
5. 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.

G. 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.

2.6 STEEL-FRAMED STAIRS

A. Stair Framing: Fabricate stringers of structural-steel channels, plates, or a combination of both, as indicated. Provide closures for exposed ends of stringers. Construct platforms of structural-steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to stringers; bolt or weld framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.

1. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

B. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067 inch.

1. Steel Sheet: Uncoated cold- or hot-rolled steel sheet.
2. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
4. Shape metal pans to include nosing integral with riser.
5. Attach abrasive nosings to risers.
6. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

2.7 FINISHES

A. Comply with NAAMM'S "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Galvanizing: Hot-dip galvanize exterior items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. Finish Painting: Finish painting of stairs is specified in Division 09 Section “Painting.”

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. 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.

F. 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.

3.2 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 51 00

SECTION 05 52 13

PIPE AND TUBE RAILINGS

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. This Section includes the following:

1. Exterior aluminum tube railings.

B. Related Sections include the following:

1. Division 05 Section "Metal Stairs" for metal stair assembly to receive aluminum tube railings.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
b. Infill load and other loads need not be assumed to act concurrently.

B. Thermal Movements: Provide exterior railings 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 calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Grout and anchoring cement.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.2, "Structural Welding Code--Aluminum."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. 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. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Aluminum Pipe and Tube Railings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ATR Technologies, Inc.
b. Blum, Julius & Co., Inc.
c. Superior Aluminum Products, Inc.
d. Tubular Specialties Manufacturing, Inc.
e. Wagner, R & B, Inc.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.3 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Tubing: ASTM B 221, Alloy 6063-T5/T52.

C. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T832.

D. Plate and Sheet: ASTM B 209, Alloy 6061-T6.

2.4 FASTENERS

A. General: Provide the following:

1. Aluminum Railings: Type 304 stainless-steel fasteners.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

D. Anchors: Provide cast-in-place chemical or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32-inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.

H. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

J. Form changes in direction as follows:

1. By bending.

K. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of railing members with prefabricated end fittings.

M. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

P. For removable railing posts, fabricate slip-fit sockets from stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.

2.7 ALUMINUM FINISHES

A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in Part 2 "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 6 inches of post.

3.3 ATTACHING RAILINGS

A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.

C. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.

3.4 ANCHORING POSTS

A. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.

C. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8-inch buildup, sloped away from post.

3.5 ADJUSTING AND CLEANING

A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.6 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 52 13

SECTION 05 53 00

METAL GRATINGS

PART 1 – GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):

a. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shape, and Tubes.

2. National Association of Architectural Metal Manufacturers (NAAMM):

a. MBG 531, Metal Bar Grating Manual.
b. MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:

a. Grating: Show dimensions, weight, and size, and location of connections to adjacent grating, supports, and other Work.
b. Grating Anchorage: Show structural calculations and details of anchorage to supports to prevent displacement from traffic impact.
c. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.
d. Catalog information and catalog cuts.
e. Manufacturer's specifications, to include coatings.

B. Informational 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.

1.03 PREPARATION FOR SHIPMENT

A. Insofar as is practical, factory assemble items provided.

B. Package and clearly tag parts and assemblies that are of necessity shipped unassembled and protect the materials from damage, and facilitate identification and final assembly in the field.

PART 2 PRODUCTS

2.01 FOOT TRAFFIC GRATING

A. Design Criteria:

1. Uniform Service Load shall be as noted on the drawings.

B. Description:

1. Aluminum Pressure Locked Bar type grating.
2. Maximum Deflection: 1/4 inch, unless otherwise shown.
3. Space bearing bars as required for design loads, with a maximum of 1-inch center-to-center.
4. Bearing bar depth shall be minimum required to meet loading requirements and design conditions.
5. Bearing bar thickness shall be 3/16" to provide ¾" between bars.
6. Top surface of bars: Slip Resistant
7. Cross Bar spacing: 2" or 4" on center, as required to meet loading requirements and design conditions.
8. Banding: 3/16 inch minimum, same material as grating; NAAMM MBG 531 and NAAMM MBG532

C. Manufacturers:

1. Ohio Gratings Inc. Type 15-ADT-2 or 4 or
2. Borden Gratings Inc., Type L or LF.

D. Materials:

1. Aluminum bearing bars and banding shall be 6063-T6 and Aluminum Cross Bars shall be 6063-T52; ASTM B221.
2. Finish: Mill Finish.

2.02 ACCESSORIES

A. Except where noted otherwise, hardware and removable fastener clips shall be stainless steel, as recommended by manufacturer, compatible with grating system, and capable of meeting the loading requirements with appropriate safety factors.

B. Removable Fastener Clips shall be removable from above grating walkway surface.

C. Partially Removable Anchor:

1. Bolt: Threaded stud, Type 304 or Type 316 stainless steel.

   a. Manufacturer: Nelson Stud Welding Co., Lorain, OH.

2. Hat Bracket: Type 304 'stainless steel.

   a. Manufacturer: STRUCT-FAST, Wellesley Hills, MA.

2.05 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. Design:

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 its 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 & Fabrication Tolerances shall be in accordance with NAAMM MBG 53l.
4. Crossbars: Flush with top of main bar and extend downward a minimum of 50 percent of the main bar depth.
6. Do not use weld type crossbars.
7. Furnish stainless steel Type 304 or Type 316 threaded anchor studs, as fasteners for grating attachment to metal supports either not embedded or partially embedded in concrete, as manufactured by Nelson Studs Welding Co., Lorain, OH.

C. Supports:

1. Seat Angles and Beams:

   a. To be designed and provided by grating manufacturer.
   b. To be same material as rectangular bar grating.
   c. Extruded aluminum frame with slot for recessed grating clips.

2. Coordinate dimensions and fabrication with grating to be supported.
3. Coordinate dimensions with increased depth due to serrations (if applicable).
4. Welded Frames with Anchors: Continuously welded.

E. Aluminum:

1. ASTM B221 extruded shapes.
2. Fabricate as shown and in accordance with manufacturer's recommendations.
3. Grind smooth sheared edges exposed in the finished work.

F. Foot Traffic Grating: Any single grating section, individual plank, or plank assembly shall be not less than 1 foot 6 inches or greater than 3 feet 0 inch in width or weigh more than 160 pounds.

PART 3 – EXECUTION

3.01 PREPARATION

A. Electrolytic Protection:

1. Aluminum in contact with dissimilar metals, other than stainless steel, and embedded or in contact with masonry, grout, and concrete, protect surfaces as specified in Section 09 90 00, Painting and Coating.
2. Allow paint to dry before installation of the material.

3.02 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations.

B. Install supports such that grating sections have a solid bearing on both ends, and that rock and wobble grating movement does not occur under designed traffic loading.

C. Install plumb or level as applicable.

D. Install welded frames with anchors to straight plane without offsets.

E. Completed installation shall be rigid and neat in appearance.

F. Protect painted surfaces during installation. Should coating become marred, prepare and touch up surface in accordance with paint manufacturer's instructions.

END OF SECTION

SECTION 06 40 13

EXTERIOR ARCHITECTURAL WOODWORK

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. This Section includes the following:

1. Exterior standing and running trim.
2. Exterior plywood soffit panels.
3. Shop priming exterior woodwork.

1.3 SUBMITTALS

A. Product Data: For each type of product and process indicated and incorporated into items of exterior architectural woodwork during fabrication, finishing, and installation.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components. Provide shop drawings for entry wood and extended rafters.

1. Show details full size.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of products.

C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of exterior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1.5 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation of exterior woodwork only when existing and forecasted weather conditions permit work to be performed and at least one coat of specified finish to be applied without exposure to rain, snow, or dampness.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

1.6 COORDINATION

A. Coordinate sizes and locations of framing, blocking, reinforcements, and other related units of Work specified in other Sections to ensure that exterior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Wood Products: Comply with the following:

1. Lumber: DOC PS 20.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA C2 (lumber) and AWPA C9 (plywood) and the following:

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
2. Kiln-dry lumber and plywood after treatment (KDAT) to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.
3. Mark each treated item with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

B. Extent of Treatment: Treat exterior architectural woodwork by pressure process.

2.3 INSTALLATION MATERIALS

A. Blocking, Shims, and Nailers: Softwood or hardwood lumber, pressure-preservative treated, fire-retardant treated where indicated, kiln dried to less than 15 percent moisture content.

B. Nails and Screws: Hot-dip galvanized or stainless steel.

C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts, unless otherwise indicated. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.4 FABRICATION, GENERAL

A. Wood Moisture Content: 15 to 19 percent.

B. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

1. Edges of Solid-Wood (Lumber) Members 3/4 Inch Thick or Less: 1/16 inch.
2. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.

C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

D. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Smooth edges of cutouts and seal with a water-resistant coating suitable for exterior applications.

2.5 EXTERIOR STANDING AND RUNNING TRIM

A. Grade: Custom.

B. Backout or groove backs of flat trim members, and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

C. Wood Species: Southern Yellow Pine, pressure preservative treated.

1. Do not use plain-sawn lumber with exposed, flat surfaces more than 3 inches wide.

2.6 EXTERIOR PLYWOOD SOFFIT PANELS AT PORCH

A. Plywood T-111 Soffit Panels: APA-rated siding, pressure-preservative treated.

1. Face Grade: 303- oc.

2. Thickness: Not less than 5/8 inch.
3. Face Species: Southern Pine.
4. Pattern: Texture 1-11; grooves 4 inches o.c.
5. Application: Textured face down at exposed underside of soffits.

2.7 MISCELLANEOUS MATERIALS

A. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches into wood substrate.

1. For pressure-preservative-treated wood, provide stainless-steel or hot-dip galvanized-steel fasteners.

B. Wood Glue: Waterproof resorcinol glue recommended by manufacturer for exterior carpentry use.

C. Flashing: Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim" for flashing materials installed in exterior finish carpentry.

2.8 SHOP PRIMING

A. Woodwork for Opaque Finish: Shop prime woodwork for paint finish with one coat of wood primer specified in Division 09 painting Sections.

B. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Deliver concrete inserts and similar anchoring devices to be built into substrates well in advance of time substrates are to be built.

C. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Quality Standard: Install woodwork to comply with same grade specified in Part 2 for type of woodwork involved.

B. Install woodwork true and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.

D. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes according to AWPA M4.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk concealed fasteners and blind nailing. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork.

F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 36 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.

1. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

G. Complete finishing work specified in this Section to extent not completed at shop or before installation of woodwork. Fill nail and screw holes with matching filler where exposed.

H. Refer to Division 09 Sections for final finishing of installed architectural woodwork.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; replace woodwork where not possible to repair. Adjust joinery for uniform appearance.

B. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION

SECTION 06 82 00

ARCHITECTURAL FIBERGLASS COLUMN COVERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, conditions of the contract and Division 01 Specifications sections, apply to work of this section.

1.2 SUMMARY

A. Section Includes: Architectural Fiberglass Reinforced Polymer (FRP) Column Covers.

1.3 RELATED SECTIONS

A. Section 05 12 00 – Structural Steel: Support framing for architectural fiberglass column cover.

B. Section 07 92 00 – Joint sealants and field applied sealants.

1.4 DESIGN REQUIREMENTS

A. Installed architectural fiberglass column covers and fastening systems shall be designed, engineered, fabricated, and installed to conform to the state codes, local codes, and the Architect's design.

1.5 SUBMITTALS

A. Shop Drawings: Shall illustrate dimensions, adjacent construction, materials, thickness, fabrications details, required clearances, field jointing, tolerances, colors, finishes, methods of support, attachments, anchorage to substrates, integration of components, and list of part numbers that coordinate with labeled architectural column covers.

B. Submit manufacturer's current valid certification with The Certified Composites Technician (CCT) program created by the American Composites Manufacturers Association (ACMA).

C. Submit manufacturer's internal Quality Control & Assurance Procedures based upon provisions published in the "Guidelines and Recommended Practices for Fiberglass Reinforced Plastic Architectural Products" upon request.

D. Product Data: Submit manufacturer's product data and installation instructions.

E. Product Samples: Submit minimum 3-inch x 5-inch samples in specified color, texture and finish when applicable.

1.6 QUALITY ASSURANCE

A. Obtain architectural fiberglass column covers from a single source manufacturer that has the ability and resources to comply with the requirements and schedule of the project.

B. Manufacturer to comply with Quality Control & Assurance Procedures, and fabricate architectural fiberglass based upon provisions published in the "Guidelines and Recommended Practices for Fiberglass Reinforced Plastic Architectural Products".

C. Inspect each molded piece to ensure that it complies with specified requirements, including nominal dimensions.

1.7 MANUFACTURER'S QUALIFICATIONS

A. Manufacturer: Provide products manufactured by a firm specializing in the manufacture of fiberglass architectural ornamentation, in the United States with a minimum of ten (10) years' experience.

B. Manufacturer shall demonstrate current valid certification and participation in the CCT program and fabricate material based upon provisions published in the "Guidelines and Recommended Practices for Fiberglass Reinforced Plastic Architectural Products".

C. Provide a list of projects comparable in size, scope, and complexity as indicated, upon request.

D. Provide verification that architectural fiberglass column cover meets or exceeds products specified.

1.8 DELIVERY, STORAGE AND HANDLING

A. Handle, store and transport architectural fiberglass column covers according to manufacturer's recommendations and in a manner that prevents damage.

B. Protect architectural fiberglass column covers from damage by retaining shipping protection in place until installation.

C. Damage Responsibility: Except for damage caused by others, the installer is responsible for chipping, cracking, or other damage to fiberglass fabrications, after delivery to the jobsite and until installation is completed and inspected and approved by the Architect.

1.9 WARRANTY

A. Warrant architectural fiberglass column covers to be free from defect due to materials and workmanship for one year.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Architectural Fiberglass, Inc.
2. EDON Corporation.
3. Melton Classics.

2.2 PATTERNS/MOLDS

A. Custom Pattern/Mockups: Patterns and mockups shall be hand carved and/or CNC machined by skilled pattern makers with minimum of ten (10) years' experience with architectural elements. Patterns & mockups shall be available at manufacturing facility for architect's inspection and approval before molds are produced.

B. Custom Molds: Molds shall be produced with ample layers of tooling resin, tooling gel-coat, glass fibers and/or flexible rubber by skilled mold makers with minimum of ten (10) years' experience with architectural elements. Produced molds shall have rigidity and thickness to prevent distortion and deflection of molded architectural fiberglass.

2.3 MATERIALS CHARACTERISTICS

A. MOLDED EXTERIOR SURFACE: NPG-ISO polyester gel coat, 18 to 22 mils thick. Gel coat shall be sandable grade for acceptance of finish paint.

B. BARRIER COAT: Specifically formulated backup polyester surface veil 18-20 mils thick to prevent glass print through and ultimate Class A finish.

C. BACK UP LAMINATE:

1. Resin: Polyester resin shall be fire retardant, and meet Class 1 flame spread rating of 25 or less and smoke density under 450 without the use of antimony trioxide as characterized by the ASTM E-84 tunnel test at typical 1/8" glass mat laminate. General Purpose resin <u>will not</u> be permitted.
2. Filler: Functional filler to be added to resin matrix to minimize shrinkage, add stiffness, control opacity, add fire retardance, improve surface finish, minimize crazing, and control dimensional stability from weather extremes.
3. Fiberglass Reinforcement: Type "E" fiberglass, glass cloth, matt and/or random chopped glass fibers. Glass content approximately 20% to 30%.
4. Laminate Thickness: Nominal laminate shall be minimum 3/16" thickness. Additional core reinforcements and/or sandwich structure added as required for rigidity and structural integrity.

2.4 FABRICATION

A. Column cover halves shall be manufactured with sufficient butt joints to provide structural integrity and shall be manufactured to accommodate construction adhesive, and align with adjoining half section.

B. Column vertical joint shall be designed to accept polyester body filler for monolithic finish and field painting.

C. Column cover shaft half sections shall be manufactured as a single unit spanning entire height from base to top of capital.

D. Column base shall be manufactured as a separate unit for column shaft height adjustment.

AVERAGE MECHANICAL PROPERTIES:

PROPERTY	VALUE	TEST METHOD
Tensile strength	12,000 PSI	ASTM D638
Flexural strength	20,000 PSI	ASTM D790
Flexural modulus	0.9×10^6 PSI	ASTM D790
Compressive strength	17,000 PSI	ASTM D695
Bearing strength	9,000 PSI	ASTM D638
Thermal expansion	10×10^{-6} (□F)	
Specific gravity	1.5	

2.5 FINISH

A. Color as selected by Architect for field painting unless otherwise specified.

B. Surface Texture/Exposed side shall be smooth ready for light sanding and painting.

2.6 TOLERANCES

A. Part Thickness: + or – 1/8 inch.

B. Gel Coat Thickness: + or – 2.5 mils.

C. Length: + or – 1/8 inch

D. Variation from Square: 1/8 inch.

E. Hardware Location Variation: + or – ¼ inch.

2.7 IDENTIFICATION

A. Identify each column cover unit with a permanent serial number.

B. Number parts to coordinate with shop drawings.

2.8 CURING AND CLEANING

A. Cure and clean components prior to shipment and remove material which may be:

1. Toxic to plant or animal life.
2. Incompatible with adjacent building material.

2.9 ANCHORS AND FASTENERS

A. Contractor to provide anchors and fasteners and other accessories for proper installation of architectural fiberglass column covers as recommended and approved by fiberglass fabrication manufacturer.

PART 3 – EXECUTION

3.1 PRE-INSTALLATION EXAMINATION

A. Carefully observe and verify field conditions that substrates are ready for installation of architectural fiberglass column covers. Contractor shall verify on site dimensions with shop drawings and assume full responsibility for fitting the components to the structure.

B. Verify that bearing surfaces are true and level.

C. Verify that support framing has been constructed to allow accurate placement, alignment and connection of architectural column covers to structure.

D. Report discrepancies between design dimensions and field dimensions, which could adversely affect installation, to the Architect.

E. Do not proceed with installation until discrepancies are corrected, or until installation requirements are modified and approved by the Architect.

F. Beginning of installation means acceptance of existing conditions and fiberglass materials.

3.2 INSTALLATION

A. Install architectural fiberglass column covers in accordance with manufacturer's instructions and approved shop drawings.

B. Fiberglass column cover vertical joint shall be field finished and painted per manufacturer's instructions for monolithic appearance.

3.3 ALLOWABLE TOLERANCES FOR INSTALLED UNITS

A. Maximum offset from True Alignment: 1/4 inch in 20 feet.

B. Maximum Variation from True Position: 1/2 inch in 20 feet.

3.4 CLEANING

A. Clean installed architectural fiberglass column covers using cleaning methods and material approved by manufacturer.

3.5 PROTECTION OF INSTALLED FABRICATIONS

A. Comply with manufacturer's recommendations and instructions for protecting installed column covers during construction activities.

END OF SECTION

SECTION 07 21 00

THERMAL INSULATION

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board.
2. Glass-fiber batts.
3. Closed cell spray foam insulation.

1.01 REFERENCES

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

1. ASTM International (ASTM):

a. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
b. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
d. E96, Standard Test Methods for Water Vapor Transmission of Materials.

1.02 DELIVERY, STORAGE, AND HANDLING

A. On packaging clearly identify manufacturer, contents, brand name, applicable standard, and R-value.

B. Store materials off ground and keep them dry at all times. Protect against weather, condensation, and damage.

PART 2 – PRODUCTS

2.01 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded Polystyrene Board, Type IV: ASTM C 578, Type IV, 25-psi minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. DiversiFoam Products.

2. Dow Chemical Company.
3. Owens Corning.
4. Pactiv.

2.02 GLASS FIBER BLANKET INSULATION

A. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

B. Manufacturers:

1. CertainTeed Corporation.
2. Johns Manville.
3. Owens Corning.

2.03 SPRAY FOAM INSULATION

A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BASF Corporation.
b. BaySystems NorthAmerica, LLC.
c. Henry Company.
d. NCFI; Division of Barnhardt Mfg. Co.
e. Icynene, Inc.

2. Minimum density of 1.5 lb/cu. ft., thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

B. Thermal Barrier for Exposed Spray Foam Insulation: Provide spray applied mineral wool thermal barrier complying with NFPA 275 “Standard Method of Fire Test for the Evaluation of Thermal Barriers Used Over Foam Plastic Insulation.” Provide 1-1/2 inch thickness, unless otherwise indicated.

1. Basis-of-Design Product: Firestop TB by Amerrock Products.

C. Ignition Barrier for Exposed Spray Foam Insulation: Provide the following in accordance with applicable code:

1. Ignition Barrier Protective Coating: Aldocoat 757 by Aldo Products Company, Inc.; 7.5-mil minimum dry mil thickness.
2. or other code approved material consistent with type of construction.

PART 3 – EXECUTION

3.01 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

A. Install board insulation over concrete or concrete masonry units using Z-shaped furring as specified in Section 09 22 16. Install according to manufacturer's written instructions.

3.02 GLASS-FIBER BLANKET INSULATION

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

B. Install glass-fiber blankets in cavities formed by framing members according to the following requirements:

1. Use blanket widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
2. Place blankets in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically.

3.03 SPRAY FOAM INSULATION

A. Spray Foam Insulation: Apply spray foam insulation to underside of floor and roof decks, as indicated and according to manufacturer's written instructions.

1. Apply spray foam insulation to thickness or R-value as indicated on Drawings (R-30 at roof).
2. Apply thermal barrier or ignition barrier over exposed spray foam insulation as required for code compliance.

END OF SECTION

SECTION 07 41 13

METAL ROOF PANELS

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. This Section includes the following:

1. Standing-seam metal roof panels.
2. Metal soffit panels.
3. Self-adhering roof underlayment.
4. Flashing and trim.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide metal roof panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.

B. Air Infiltration: Air leakage of not more than 0.003 cfm/sq. ft. when tested according to ASTM E 1680 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:

1. Test-Pressure Difference: 8.00 lbf/sq. ft.

D. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift resistance class indicated.

E. Uniform Wind Load Capacity: Design, size and install components to withstand positive and negative wind loading pressures in accordance with applicable Code, as verified by Structural Engineer.

F. Structural Performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and wind loads as indicated on Structural Drawings, based on testing according to ASTM E 1592.

G. Thermal Movements: Provide metal roof panel assemblies 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 joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal roof panel and accessory.

1. Provide information for roll-forming equipment and certified operator.

B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Provide calculations of potential expansion and contraction of panels and indicate details to accommodate movement.

C. Coordination Drawings: Roof plans drawn to scale and coordinating penetrations and roof-mounted items. Show the following:

1. Roof panels and attachments.
2. Roof-mounted items.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Roof and Soffit Panels: 12 inches long by actual panel width. Include fasteners, clips, fascias, closures, and other metal roof panel accessories at roof edge.
2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: 12-inch- long Samples for each type of accessory.

E. Qualification Data: For Installer.

F. Field quality-control inspection reports.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for the following:

1. Metal Roof Panels: Include reports for air infiltration, water penetration, and structural performance.

H. Maintenance Data: For metal roof panels to include in maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer or workers trained and certified by the manufacturer of standing seam roof systems. Installer must provide certification and proof of formal training and certification by the manufacturer who requires same training and certification for issuance of specified warranties.

1. Installer's responsibilities include fabricating and installing metal roof panel assemblies and providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of data for metal roof panels, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Sole Source Responsibility for Roofing: A single Roofing Contractor shall be responsible for providing, coordinating and installing all types of roofing required for project.

C. UL-Certified, Portable Roll-forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work. Portable roll-forming equipment must have a minimum of 16 stands and must be operated by a factory trained technician. On-site roll-forming by the roofing contractor is not acceptable.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal roof panel Installer, metal roof panel manufacturer's representative, deck Installer, and installers whose work interfaces with or affects metal roof panels including installers of roof accessories.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays. Ensure that metal roof panel installation schedule will prevent water intrusion which could promote mold growth.
3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.
4. Examine deck substrate conditions for compliance with requirements, including flatness and attachment to structural members.
5. Review structural loading limitations of deck during and after roofing.
6. Review flashings, special roof details, roof drainage, roof penetrations, and condition of other construction that will affect metal roof panels.
7. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
8. Review temporary protection requirements for metal roof panel assembly during and after installation.
9. Review roof observation and repair procedures after metal roof panel installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.

B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify locations of roof framing and roof opening dimensions by field measurements before metal roof panel fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate installation of roof curbs and roof penetrations.

B. Coordinate metal panel roof assemblies with rain drainage work, flashing, trim, and construction of decks, parapets, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal roof panel assemblies that fail in materials or workmanship within specified warranty period. No Dollar Limit of Liability.

1. Failures include, but are not limited to, the following:
    a. Structural failures, including rupturing, cracking, or puncturing.
    b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: Ten years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.
2. Concealed Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
3. Surface: Smooth, striated finish.

2.2 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating.

1. Fasteners for Roof Panels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal roof panels.
2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be field assembled by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a striated pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together with narrow batten.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AEP-Span.
   b. McElroy Metal, Inc. – “Medallion I” (Basis of Design).
   c. Metal Sales Manufacturing Corporation.

d. Petersen Aluminum Corporation.
e. Tremco.

2. Material: Aluminum-zinc alloy-coated steel sheet, 0.028 inch thick (24 gage).

   a. Exterior Finish for Roof Panels: "Galvalume Plus" or equal.

3. Clips: One-piece fixed to accommodate thermal movement.

   a. Material: 0.028-inch- thick, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

4. Panel Coverage: 16 inches.
5. Panel Height: 1 inch.
6. Uplift Rating: UL 120, or as otherwise required to withstand positive and negative wind loading pressures in accordance with International Building Code for applicable mph wind speed, as verified by structural engineer.

2.4 METAL SOFFIT PANELS

A. General: Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Flush-Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between edges, with flush joint between panels. Soffit panel to be equal to Marquee-Lok by McElroy Metal.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Marquee-Lok by McElroy Metal or Architect approved comparable product.
2. Material: Same material as metal roof panels.

   a. Nominal Thickness: 0.028 inch.
   b. Exterior Finish: Two-coat fluoropolymer.
   c. Color: As selected by Architect from manufacturer's full range.

3. Panel Coverage: 12 inches.
4. Panel Height: 1.0 inch.

2.5 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: 30 to 40 mils thick minimum, consisting of slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
3. Products: Subject to compliance with requirements, provide one of the following:

   a. Carlisle Coatings & Waterproofing Inc., Div. of Carlisle Companies Inc.; CCW WIP 300HT.
   b. Cetco; Strongseal.
   c. Henry Company; Blueskin High Temp.

2.6 ACCESSORIES

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Formed from minimum 0.024-inch- thick, aluminum-zinc alloy-coated steel sheet. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

1. Color: To match roof panels, unless indicated otherwise.

D. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.7 FABRICATION

A. General: Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Where indicated, fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.

C. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

2. Seams: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal roof panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal roof panel manufacturer for application but not less than thickness of metal being secured.

2.8 FINISHES, GENERAL

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of work.

1. Examine roof framing to verify that rafters and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on roof sheathing under metal roof panels. Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply over entire roof area, in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

3.4 METAL ROOF PANEL INSTALLATION

A. General: Install metal roof panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal roof panels.
2. Flash and seal metal roof panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal roof panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal roof panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.

2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Watertight Installation:

    a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
    b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
    c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

3.5 METAL SOFFIT PANEL INSTALLATION

A. General: Install metal soffit panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal soffit panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal soffit panels.
2. Flash and seal metal soffit panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal soffit panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal soffit panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal soffit panel manufacturer.

D. Lap-Seam Metal Soffit Panels: Fasten metal soffit panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal soffit panels.
3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.

4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

E. Watertight Installation:

1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal soffit panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

3.6 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Pipe Flashing: Form flashing around pipe penetration and metal panels. Fasten and seal to panel as recommended by manufacturer.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.

C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113

SECTION 07 46 46

FIBER-CEMENT TRIM

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. This Section includes the following:

1. Fiber-cement trim.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 PERFORMANCE REQUIREMENTS

A. Uniform Wind Load Capacity: Design, size and install components to withstand positive and negative wind loading pressures in accordance with International Building Code, as determined by Structural Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials in a dry, well-ventilated, weathertight place.

1.6 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only if substrate is completely dry and if existing and forecasted weather conditions permit siding to be installed according to manufacturer's written instructions.

1.7 SEQUENCING

A. Coordinate installation with flashings and other adjoining construction to ensure proper sequencing.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace trim that does not comply with requirements or that fails within specified warranty period. Failures include, but are not limited to, cracking, deforming, or otherwise deteriorating beyond normal weathering.

1. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIBER-CEMENT TRIM

A. Fiber Cement Trim: Made from fiber-cement board that does not contain asbestos fibers; complies with ASTM C 1186, Type A, Grade II; classified as noncombustible when tested according to ASTM E 136.

1. Size: As indicated on drawings.
2. Texture: Smooth.
3. Thickness: As indicated.
4. Finish: Factory prime painted.

B. Elastomeric Joint Sealant: Single-component nonsag urethane joint sealant.

1. Caulk all joints between fiber cement trim pieces.

C. Fasteners: Stainless steel.

1. Stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of trim. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Clean substrates of projections and substances detrimental to application.

3.2 INSTALLATION

A. Fiber Cement Trim: Comply with manufacturer's written installation instructions applicable to products and applications indicated, unless more stringent requirements apply.

1. Install flashing around all wall openings.
2. Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum 3/4 inch or full thickness of sheathing. Additional fasteners may be required to ensure adequate security.

3. Place fasteners no closer than 3/4 inch and no further than 2 inches from side edge of trim board and no closer than 1 inch from end. Fasten maximum 16 inches on center.
4. Maintain clearance between trim and adjacent finished grade.
5. Trim inside corner with a single board trim both side of corner.
6. Outside Corner Board Attach Trim on both sides of corner with 16 gage corrosion resistant finish nail 1/2 inch from edge spaced 16 inches apart, weather cut each end spaced minimum 12 inches apart.
7. Allow 1/8 inch gap between trim and adjacent cladding. Seal gap with high quality, paint-able caulk.

3.3 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 46 46

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 – GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):

a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
b. C920, Standard Specification for Elastomeric Joint Sealants.
c. C 1311, Standard Specification for Solvent Release Sealants.
d. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
e. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
fi. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Architectural Sheet Metal Manual, 5th Edition.

1.02 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Fabricate and install roof edge flashing capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49.

C. Wind Pressure: Provide anchorage for sheet metal flashing and trim that resists wind pressures as shown on Structural Drawings.

D. Thermal Movements:

1. Provide sheet metal flashing and trim that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.
2. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
3. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

E. Water Infiltration: Provide sheet metal flashing and trim that does not allow water infiltration to building interior.

1.03 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown, unless more stringent requirements are indicated.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:

a. Show joints, types and location of fasteners, and special shapes.
b. Catalog data for stock manufactured items.

2. Samples: Color Samples for items to be factory finished.

1.05 DELIVERY, HANDLING, AND STORAGE

A. Inspect for damage, dampness, and wet storage stains upon delivery to Work Site.

B. Remove and replace damaged or permanently stained materials that cannot be restored to like-new condition.

C. Carefully handle to avoid damage to surfaces, edges, and ends.

D. Do not open packages until ready for use.

E. Store materials in dry, weathertight, ventilated areas until immediately before installation.

PART 2 – PRODUCTS

2.01 METALS

A. Prefinished Aluminum Sheet: ASTM B209, alloy and temper as required for application and finish: 0.032-inch thick; mill finish; shop pre–coated with fluoropolymer coating (Kynar polyvinylidene fluoride resin) coating; color as selected by Architect.

B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 316, dead soft, fully annealed; with smooth, flat surface; 0.016 inch thick unless otherwise indicated; 2D finish.

2.02 TYPICAL FLASHING AND TRIM

A. Stainless steel sheet.

2.03 GUTTERS AND DOWNSPOUTS

A. Prefinished aluminum sheet.

2.04 ANCILLARY MATERIALS

A. Sealing Tape: Polyisobutylene sealing tape.

B. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil thick minimum polyester.

C. Plastic Roof Cement: ASTM D4586, Type ll.

D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.

G. Fasteners:

1. For Stainless Steel: Stainless steel.
2. For Aluminum: Stainless steel or aluminum; reglet fasteners may be galvanized or cadmium-plated steel.

2.05 FABRICATION OF FLASHING

A. Field measure prior to fabrication.

B. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual that apply to design, dimensions, metal, and other characteristics of item indicated.

C. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

D. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

E. Seams for Stainless Steel: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

F. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

G. Reinforcements and Supports: Provide same material as flashing, unless other material is shown. Steel, where shown or required, shall be galvanized or stainless.

H. Rigid Joints and Seams: Make mechanically strong. Seal aluminum joints with sealant.

I. Sealed Joints: Form non–expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

J. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than l-inch deep, filled with butyl sealant concealed within joints.

K. Fabricate sheet metal in 10-foot maximum lengths, unless otherwise indicated.

L. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

M. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" and FMG Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

2.06 FABRICATION OF GUTTER AND DOWNSPOUTS

A. Gutters and Downspouts: Manufactured formed gutter in uniform section lengths not exceeding 12 feet, with mitered and welded or soldered corner units, end caps, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front gutter rim. Furnish with flat-stock gutter straps and gutter support brackets and expansion joints and expansion-joint covers fabricated from same metal as gutters.

1. Fabricate gutter from aluminum sheet, 0.032 inch thick.
2. Gutter Style: As indicated, according to SMACNA's "Architectural Sheet Metal Manual."
3. Downspouts: Rectangular with mitered elbows, manufactured from formed aluminum, 0.032 inch thick. Furnish wall brackets, from same material and finish as downspouts, with anchors.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Flashing:

1. General: Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.
2. Isolate metal from wood and concrete and from dissimilar metal with isolation tape or two coats of isolation paint.
3. Use only stainless steel fasteners to connect isolated dissimilar metals.
4. Joints: 10-foot maximum spacing and 2-1/2 feet from corners, butted with 3/16-inch space centered over matching 8-inch-long backing plate with sealing tape in laps.
5. Set flanges of flashings and roof accessories on continuous sealer tape or in plastic roof cement on top of envelope ply of roofing. Nail flanges through sealing tape and at 3-inch maximum spacing. Touch up isolation paint on flanges.
6. Joints, Fastenings, Reinforcements, and Supports: Sized and located as required to preclude distortion or displacement due to thermal expansion and contraction.
7. Provide continuous hold–down clips at counter flashing and gravel stops.
8. Conceal fastenings wherever possible.
9. Set flashing and sheet metal to straight, true lines with exposed faces aligned in proper plane without bulges or waves.

B. Prefabricated Metal Systems:

1. Follow system manufacturer's printed instructions.
2. Place color variations in pieces so no extremes are next to each other.

3.03 GUTTERS AND DOWNSPOUTS

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at

eave or fascia to firmly anchored gutter brackets spaced not more than 36 inches apart. Provide end closures and seal watertight with sealant. Slope to downspouts.

1. Fasten gutter spacers to front and back of gutter.
2. Anchor and loosely lock back edge of gutter to continuous cleat.
3. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.

C. Downspouts: Join sections with 1-1/2-inch telescoping joints.

1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c. in between.

3.04 FINISH

A. Exposed Surfaces of Flashing and Sheet Metalwork: Free of dents, scratches, abrasions, or other visible defects, and clean and ready for painting where applicable.

3.05 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

C. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 – GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):

a. E814, Test Method for Fire Tests of Through-Penetration Firestops.

2. Underwriters Laboratory, Inc. (UL):

a. 1479, Fire Tests of Through-Penetration Firestops.
b. 2079, Tests for Fire Resistance of Building Joint Systems.

1.02 SYSTEM DESCRIPTION

A. Provide systems of material or combination of materials used to fill openings around penetrating items to prevent the spread of fire and retain integrity of fire rated construction by maintaining an effective barrier against spread of flame, smoke, water, and hot gases through penetrations in fire rated wall and floor assemblies.

B. Provide Fire Safing:

1. At slot gaps between edge of floor slabs and exterior walls.
2. Gaps between top of walls and structure above.
3. Expansion joints in walls, floors, and ceilings.

C. Performance Requirements: Provide firestop systems with materials that have been manufactured and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.

D. Regulatory Requirements:
1. Firestop Systems: Meet requirements of ASTM E814, UL 1479, or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.
2. Proposed Firestop Materials and Methods: Conform to applicable governing codes having local jurisdiction.
3. Meet F and T ratings of ASTM E814 for a period equal to construction penetrated.
4. Underwriters Laboratories classified as fill, void, or cavity materials under UL 1479.

1.03 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings: Show layout, profiles, and product components; include UL Systems Number on Shop Drawings and diagram of UL approved assembly.
   2. Product Data: Include manufacturer's SPEC-DATA® product sheet for products selected for use.

B. Informational Submittals:

   1. Manufacturer's installation instructions.

   2. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.

   3. Certificates:

      a. Product certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical requirements.
      b. Certificate indicating installer qualifications.
      c. Certificate of Proper Installation.

   4. Special Guarantee documents specified below.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Experienced in performing Work of this section and specialized in the installation of work similar to that required for this Project.

B. Pre-installation Meetings: Conduct pre-installation meeting to identify where seals are required and verify Project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at Project Site.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification and UL listing mark intact.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.

D. Follow recommended procedures, precautions, or remedies described in Material Safety Data Sheets as applicable.

1.06 SEQUENCING AND SCHEDULING

A. Firestopping requirements may be created by mechanical and electrical portions of the Work:

1. Identify locations requiring firestopping.
2. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

1.07 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction of equipment found defective during a period of 2 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

PART 2 – PRODUCTS

2.01 GENERAL

A. Furnish firestop system products from a single manufacturer.

2.02 MANUFACTURERS

A. 3M Corp.; Firestopping Products.

B. Hilti Construction Chemicals; High Performance Firestop Systems.

C. International Protective Coatings Corp. (IPC); Flamesafe Firestop Products.

D. Isolatek International (Cafco); TPS.

E. Specified Technologies; Inc. (STI).

2.03 MIXES

A. For those products requiring mixing prior to application, follow firestopping manufacturer's directions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce firestopping products of uniform quality with optimum performance characteristics for application indicated.

PART 3 – EXECUTION

3.01 EXAMINATION

A. With manufacturer's representative, examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning: Clean openings and joints immediately prior to installing firestopping in accordance with firestop manufacturer recommendations and the following requirements:

1. Remove foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form release agents from concrete.

B. Priming: Prime substrates where recommended by firestopping manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed upon completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestopping materials. Remove tape as soon as it is possible to do so without disturbing firestopping seal with substrates.

3.03 INSTALLATION

A. Manufacturer's Instructions: Follow manufacturer's instructions for installation of through-penetration systems selected for use.

1. Seal holes or voids made by penetrations for pipes, conduits, and ducts through fire-rated floors, walls, and roofs and to ensure air and water resistant seals.
2. Receive Engineer's approval prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.

B. Fire Safing: Install, following manufacturer's instructions, to completely fill gaps between tops of fire-rated walls and floor or roof deck above, between edge of floors and walls, and other locations indicated on Drawings.

C. Meet Underwriters Laboratories and Factory Mutual requirements.

3.04 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of Work accessible until inspection by applicable code authorities.

C. Perform patching and repairing of firestopping caused by cutting or penetrating existing firestop systems.

3.05 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation, and training of installer's personnel in proper installation procedures.

3.06 PROTECTION

A. Protect installed product from contact with contaminating substances and from damage during construction.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 – GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):

a. C661, Standard Test Method for Indentation Hardness of Elastomeric Type Sealants by Means of a Durometer.
b. C834, Standard Specification for Latex Sealants.
c. C920, Standard Specification for Elastomeric Joint Sealants.
d. C1193, Standard Guide for Use of Joint Sealants.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Surface preparation instructions. Indicate where each product is proposed to be used.
2. Samples: Material proposed for use showing color range available.

B. Informational Submittals:

1. Installation instructions.
2. Documentation showing applicator qualifications.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
4. Special guarantee.

1.03 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum of 5 years' experience installing sealants in projects of similar scope.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Ambient Temperature: Between 40 degrees F and 80 degrees F when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

1.05 SPECIAL GUARANTEE

A. Product: Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction of equipment found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or

removal and replacement of defective Work shall be as specified in the General Conditions.

B. Conditions: No adhesive or cohesive failure of sealant.

C. Sealed Joints: Watertight and weather-tight with normal usage.

PART 2 – PRODUCTS

2.01 SEALANT MATERIALS

A. Characteristics:

1. Uniform, homogeneous.
2. Free from lumps, skins, and coarse particles when mixed.
3. Non-staining, non-bleeding.
4. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
5. Immersible may be substituted for non-immersible.

B. Color: Unless specifically noted, match color of the principal wall material adjoining area of application.

C. Type I-Silicone, Non-sag, Non-immersible:

1. Silicone base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Capable of withstanding movement up to 50 percent of joint width.
3. Manufacturers and Products:

    a. Dow Coming Corp.; No. 790.
    b. General Electric; Silpruf.
    c. BASF; Sonneborn, Omniseal-50.

D. Type 2-Multipart Polyurethane, Self-leveling, Immersible:

1. Polyurethane base, multi component, chemical curing; ASTM C920, Type M, Grade P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:

    a. BASF; Sonneborn, SL-2.
    b. Pecora Corp.; Urexspan NR-200.
    c. Tremco; THC-900/901.
    d. Sika Chemical Corp.; Sikaflex 2c SL.

E. Type 4-Multipart Polyurethane, Nonsag, Immersible:

1. Polyurethane base, multi component, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
2. Manufacturers and Products:

a. Pecora; DynaTrol ll.
b. Tremco; Dymeric 240.
c. BASF; Sonneborn NP-2.
d. Sika Chemical Corp.; Sikaflex 2c NS.

F. Type 5-One-part Polyurethane, Immersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products for Non-sag:

a. Sika Chemical Corp.; Sikaflex-la.
b. Tremco; Vulkem 116.

4. Manufacturers and Products for Self-leveling:

a. BASF; Sonneborn, SL-l.
b. Tremco; Vulkem 45.
c. Sika Chemical Corp.; Sikaflex lc SL.
d. two-part.

G. Type 8-0ne-Part Polysulfide, Non-sag, Non-immersible:

1. Polysulfide base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 12-1/2.
2. Capable of withstanding movement up to 20 percent of joint width.
3. Manufacturer and Product: W. R. Meadows; Deck-O-Seal, one-part.

H. Type 10 Sanitary Sealant:

1. Silicone sealant similar to Type I, above, formulated to resist mold growth and repeated exposure to high humidity while retaining adhesion, flexibility, and color.

2. Manufacturers and Products:

a. Dow Corning; 786.
b. General Electric; Sanitary Sealant SCS 1700.

I. Type 11-Fire Penetration Seal:

1. Manufacturers and Products:

a. 3M Corp.; Fire Barrier Caulk CP25 and Putty 303.
b. General Electric; Pensil Sealant or Foam.
c. Unifrax Corporation; Fyre Putty.
d. Hilti USA; CP 604.

J. Type 12-One-Part Polycarbonate, Immersible:

1. Polycarbonate base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.

2. Capable of being continuously immersed in water.
3. Manufacturer and Product: Pro-Seal Products, Inc.; Pro-Seal 34.

K. Type 13-Tape Sealant:

1. Compressible polyurethane foam impregnated with polybutylene or polymer-modified asphalt.
2. Color: Black.
3. Size: 3/4 inch wide by length required by expanded thickness recommended by manufacturer for particular application.
4. Manufacturers and Products:

a. Emseal Joint Systems, Ltd.; AST-High Acrylic.
b. Dayton Superior; Polytite Standard.
c. PARR Technologies; PARR Sealant EP-7212-T.

2.02 BACKUP MATERIAL

A. Non-gassing, extruded, closed-cell round polyurethane foam or polyethylene foam rod, compatible with sealant used, and as recommended by sealant manufacturer.

B. Size: As shown or as recommended by sealant material manufacturer. Provide for joints greater than 3/16 inch wide.

C. Manufacturers and Products:

1. Sonneborn; Sonolastic Closed-cell Backing Rod.
2. Tremco; Closed-cell Backing Rod.
3. Pecora Corporation; Green Rod.

2.03 ANCILLARY MATERIALS

A. Bond Breaker: Pressure sensitive tape as recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Noncorrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Primer: Non-staining type recommended by sealant manufacturer to suit application.

2.04 PREFORMED SEALS

A. Preformed Compressible Joint Seals:

1. Widths Up to 5 Inches:

a. BASF, Watson Bowman Acme Div.; Wabo Weatherseal II.

b. Emseal Joint Systems Limited; Colorseal.
c. LymTal International; Iso-flex Joint System.

2. Other Widths: Series or model recommended by seal manufacturer.

PART 3 – EXECUTION

3.01 GENERAL

A. Use of more than one material for the same joint is not allowed unless approved by sealant manufacturer.

B. Install joint sealants in accordance with ASTM C1193.

C. Horizontal and Sloping Joints up to 1 Percent Maximum Slope: Use self-leveling (Grade P) joint sealant.

D. Steeper Sloped Joints, Vertical Joints, and Overhead Joints: Use non-sag (Grade NS) joint sealant.

E. Use joint sealant as required for the applicable application and as follows:

Joint Size	Sealant Type
Less than 1"	1, 2, 3, 4, 5, 6, 7, 8, 9,10, or 12
Less than 2"	1, 2, 3, 4, or 7
Over 2"	Follow manufacturer's recommendation

3.02 PREPARATION

A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.

B. Surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials.

1. Mask adjacent surfaces where necessary to maintain neat edge.
2. Starting of work will be construed as acceptance of sub-surfaces.
3. Apply primer to dry surfaces as recommended by sealant manufacturer.

C. Verify joint shaping materials and release tapes are compatible with sealant.

D. Examine joint dimensions and size materials to achieve required width/depth ratios.

E. Follow manufacturer's instructions for mixing multi-component products.

3.03 INSTALLATION

A. Use joint filler to achieve required joint depths, to allow sealants to perform intended function.

1. Install backup material as recommended by sealant manufacturer.
2. Where possible, provide full length sections without splices; minimize number of splices.
3. Tape sealant may be used as joint filler if approved by sealant manufacturer.

B. Use bond breaker where recommended by sealant manufacturer.

C. Seal joints around window, door and louver frames, expansion joints, control joints, and elsewhere as indicated.

D. Joint Sealant Materials: Follow manufacturer's recommendation and instructions, filling joint completely from back to top, without voids.

E. Joints: Tool slightly concave after sealant is installed.

1. When tooling white or light color sealant, use water wet tool.
2. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.

F. Tape Sealant: Compress to 50 percent of expanded thickness and install in accordance with manufacturer's instructions.

3.04 PREFORMED SEALS

A. Prepare joint surfaces clean and dry, free from oil, rust, laitance, and other foreign material.

B. Construct joints straight and parallel to each other and at proper width and depth.

C. Apply joint sealant manufacturer's approved primer and adhesive in accordance with manufacturer's instructions.

D. Install seal in accordance with manufacturer's instructions.

3.05 CLEANING

A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.

B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

3.06 JOINT SEALANT SCHEDULE

A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of Project.

Joint Locations	Sealant Type(s)
Expansion/Contraction and Control Joints At:	
Concrete Walls (except water-holding) and below-grade portions of structures	1, 5, 12
Concrete Floor Slabs (except for water-holding Structures	2, 5
Slabs Subject to Vehicle and Pedestrian Traffic	2, 5
Masonry Walls	1, 4, 5, 12, 13
Exterior Insulation and Finish System	4
Ceramic Tile Floors	1, 2, 5, 10
Ceramic Tile Walls	1, 5, 10
Pre-cast Concrete Wall Panels	4, 5, 12, 13
Materials Joint At:	
Metal Door, Window, and Louver Frames (Exterior)	1, 5, 8, 12
Metal Door, Window, and Louver Frames (Interior)	1, 5, 8
Wall Penetrations (Exterior)	1, 5, 8, 12
Wall Penetrations (Interior)	1, 5, 6, 8
Floor Penetrations	5
Ceiling Penetrations	1, 4, 5
Roof Penetrations	5
Sheet Metal Flashings	5, 13
Sheet Metal Roofing and Siding	5, 13
Glazed Concrete Masonry Unit Joints	1
Other Joints	
Threshold Sealant Bed	5
Between Counter Tops and Backsplashes	10
Around Plumbing Fixtures	10
Opening Around Pipes, Conduits, and Ducts Through Fire-Rated Construction	11
Concrete Form Snap-Tie Holes	1, 4, 5

END OF SECTION

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

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. This Section includes the following:

1. Steel doors.
2. Steel door frames.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

1.4 QUALITY ASSURANCE

A. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having

jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: After 5 minutes into the test, the neutral pressure level in the furnace shall be established at 40 inches or less above the sill.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.

C. Store doors and frames at building site under cover. Place units on minimum 4-inch-high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hot-Rolled Steel Sheets: ASTM A 569/A 569M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

B. Cold-Rolled Steel Sheets: ASTM A 366/A 366M, Commercial Steel (CS), or ASTM A 620/A 620M, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.

C. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

2.2 DOORS

A. General: Provide doors of sizes, thicknesses, and designs indicated.

B. Interior Doors: Face sheets fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior door requirements. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless).

2.3 FRAMES

A. General: Provide steel frames for doors, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile.

B. Interior Frames: Fabricated from cold-rolled steel sheet, shop primed.

1. Fabricate knocked-down frames with mitered or coped corners, for field assembly.
2. Frames for Wood and Steel Doors: 0.053-inch- thick steel sheet, unless otherwise indicated.

C. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.

D. Supports and Anchors: Fabricated from not less than 0.042-inch- thick, electrolytic zinc-coated or metallic-coated steel sheet.

1. Wall Anchors in Masonry Construction: 0.177-inch-diameter, steel wire complying with ASTM A 510 may be used in place of steel sheet.

E. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A 153/A 153M, Class C or D as applicable.

2.4 ACCESSORIES

A. Louvers: Provide louvers for interior doors, where indicated, which comply with SDI 111C, with blades or baffles formed of 0.020-inch- thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame.

1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.

2.5 FABRICATION

A. General: Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Core Construction: Manufacturer's standard core construction that produces a door complying with SDI standards.

C. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.

D. Clearances for Fire-Rated Doors: As required by NFPA 80.

E. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

F. Fabricate concealed stiffeners, reinforcement, edge channels, and moldings from either cold- or hot-rolled steel sheet.

G. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

H. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.

I. Frame Construction: Fabricate frames to shape shown.

1. For exterior applications, fabricate frames with mitered or coped and continuously welded corners and seamless face joints.
2. For interior applications, fabricate knock-down frames with mitered or coped corners, for field assembly.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:

1) Two anchors per jamb up to 60 inches high.
2) Three anchors per jamb from 60 to 90 inches high.
3) Four anchors per jamb from 90 to 120 inches high.

b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches high.
2) Four anchors per jamb from 60 to 90 inches high.
3) Five anchors per jamb from 90 to 96 inches high.

c. Compression Type: Not less than two anchors in each frame.
d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

J. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

K. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

2.6 FINISHES

A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.

B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable stops located on secure side of opening.
    d. Install door silencers in frames before grouting.
    e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
4. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
5. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
6. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
c. At Bottom of Door: 3/4 inch plus or minus 1/32 inch.
d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

3.2 ADJUSTING AND CLEANING

A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.

B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

SECTION 08 16 13

FIBERGLASS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fiberglass doors and frames.

1.2 REFERENCES

A. American Architectural Manufacturer Association (AAMA)

1. AAMA 1304; Voluntary Specification for Forced Entry Resistance of Side-Hinged Door Systems.

B. ASTM International

1. ASTM E283; Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
2. ASTM E330; Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Pressure Difference
3. ASTM E331; Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
4. ASTM E547; Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference
5. ASTM E 1886; Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
6. ASTM E 1996; Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

1.3 DESIGN REQUIREMENTS

A. Structural Requirements – Provide doors and frames capable of complying with requirements indicated:

1. Design pressure: As indicated on drawings

B. Impact (Windborne-Debris) Resistance

1. Doors and frames capable of resisting impact from windborne debris, when tested in accordance with ASTM E1886 and ASTM E1996.

1.4 SUBMITTALS

A. Product Data: Submit door manufacturer current product literature, including installation instruction.

B. Samples: Provide finish samples for all products.

C. Quality Assurance Submittals

1. Design Data: Provide manufacturer test report numbers indicating product compliance with indicated requirements.
2. Manufacturer Instructions: Provide manufacturer's written installation instructions.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver doors, frames, materials and components in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Store doors and frames as recommended by manufacturer.

1.6 WARRANTY

A. Manufacturer standard warranty indicating that doors and frames will be free from material and workmanship defects from the date of substantial completion for the time periods indicated below:

1. Fiberglass Doors and Frames: 3 Years.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or Architect approved comparable manufacturer:

1. JELD-WEN® Fiberglass Doors.
2. Plastpro.
3. Therma-Tru.

B. Door Style: Smooth, flush fiberglass doors.

2.2 MATERIALS

A. Stiles and Rails: Engineered wood (laminated veneer lumber), composite capped.

2.3 FIBERGLASS DOORS

A. Thickness: 1-3/4 inch.

B. Door Style: Solid.

C. Door Shape: Squared Top.

D. Finish: Field painted.

E. Hardware: As provided by Section 08 71 00.

2.4 FIBERGLASS FRAMES

A. Non-Rated Construction: One-piece pultruded fiberglass reinforced plastic, minimum 1/4 inch wall thickness, jamb-to-head joints mitered and reinforced with FRP clips and stainless steel fasteners; conforming to SDI requirements for performance equivalent to 16 gage steel frames or Stainless Steel hollow metal frames.

B. Frame Profile and Size: As indicated on Drawings.

C. Hardware Preparation: Mortise for lock strike, and recess for strike plate in lock jamb. Reinforce for hinges and other indicated hardware.

2.5 CONSTRUCTION ACCESSORIES

A. Sealants

1. Refer to Section 07 92 00 Joint Sealants.
2. Provide manufacturer recommended sealants maintain watertight conditions.

2.6 FABRICATION

A. Skins are adhered to engineered wood frames with core materials and bonding agents that permanently lock skin to frame.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive work and opening dimensions and clearances are as indicated on approved shop drawings. Do not begin installation until openings have been properly prepared.

B. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Acclimate doors and frames to site conditions for a minimum of 24 hours before installation.

3.2 INSTALLATION

A. Install door opening assemblies in accordance with approved shop drawings, SDI 100, and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.

B. Site Tolerances: Maintain plumb and level tolerances specified in manufacturer's printed installation instructions.

C. Hardware: For installation, see Division 08 Section "Door Hardware."

3.3 ADJUSTING

A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding, and to remain in place at any angle without being moved by gravitational influence.

B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

C. Operation: Rehang or replace doors that do not swing or operate freely.

3.4 PROTECTION

A. Protect installed doors from damage.

END OF SECTION 08 16 13

SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM): A36/ A36M, Standard Specification for Carbon Structural Steel.
2. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
3. National Fire Protection Association (NFPA): 70, National Electrical Code.

1.02 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads as determined by Structural Engineer.

1. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
2. Operability under Wind Load: Design overhead coiling doors to remain operable under uniform pressure (velocity pressure) of minimum 20 lbf/sq. ft. wind load, acting inward and outward.

B. Windborne-Debris Impact Resistance: Provide impact-protective overhead coiling doors that pass missile-impact and cyclic-pressure tests according to ASTM E 1996 for Wind Zone 2.

1. Large-Missile Test: For overhead coiling doors located within 30 feet of grade.

1.03 SUBMITTALS

A. Action Submittals: Construction and installation.

B. Informational Submittals: Installer's factory authorization.

1.04 QUALITY ASSURANCE

A. Qualifications: Experienced, factory authorized installer.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Description: Complete, interior face-mounted rolling service door assemblies,

weather sealed and able to withstand wind pressures as stated on Structural Drawings. The design features below are minimum requirements. Construction of door submitted must be able to withstand calculated design pressures.

B. Features:

1. Curtain: Interlocking flat, minimum 20-gauge steel slats.
2. Hood: Match curtain material.
3. Slide Guides and Wall Angle: Impact tested; ASTM A36 steel shapes as appropriate for conditions.
4. Brackets, Gears, and Barrel: Manufacturer's standard items.
5. Bottom Bar: Steel bottom bar with flexible weather stripping astragal on all exterior doors.
6. End Locks and Wind Locks: End locks at ends of each slat, of material compatible with curtain. Provide wind locks at ends of every other slat minimum on exterior doors.
7. Weather Seals:

    a. Rubber, neoprene, or vinyl water seal at hood to prevent airflow around coil on exterior doors.
    b. Weather seal sealing strip on guide to close space between guide and curtain on exterior doors.

8. Finish:

    a. Curtain Slats, Bottom Bar, and Hood: Galvanized and prime painted.
    b. Other Steel Surfaces: Corrosion-inhibiting prime paint, compatible with finish paint specified in Section 09 90 00, Painting and Coating.

9. Locking: Manufacturer's standard slide bolt.

C. Operator: Continuous chain.

D. Manufacturers and Products:

1. The Cookson Co.
2. Cornell Iron Works.
3. Overhead Door Corp.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

3.02 ADJUSTING AND CLEANING

A. Adjust doors and operators for smooth, easy operation.

1. Adjust exterior doors and components to be weather-resistant.

B. Leave door assemblies clean, ready for paint.

END OF SECTION

SECTION 087100

DOOR HARDWARE

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. This Section includes the following:

1. Commercial door hardware.
2. Cylinders for doors specified in other Sections.

B. Related Sections include the following:

1. Division 08 Section "Hollow Metal Doors and Frames."

1.3 SUBMITTALS

A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

C. Warranty: Special warranty specified in this Section.

D. Other Action Submittals:

1. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
c. Content: Include the following information:

1) Identification number, location, hand, fire rating, and material of each door and frame.
2) Type, style, function, size, quantity, and finish of each door hardware item.
3) Complete designations of every item required for each door or opening including name and manufacturer.
4) Fastenings and other pertinent information.
5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
6) Explanation of abbreviations, symbols, and codes contained in schedule.
7) Mounting locations for door hardware.
8) Door and frame sizes and materials.

d. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.

e. Submittal Sequence: Submit initial draft of final schedule along with essential Product Data to facilitate the fabrication of other work that is critical in Project construction schedule. Submit the final door hardware sets after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.

2. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.4 QUALITY ASSURANCE

A. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

B. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UBC Standard 7-2.

1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

D. Deliver keys to Owner in person, by registered mail or overnight package service.

1. Keys can be turned over to the Contractor under written direction from the owner only.

1.6 COORDINATION

A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of operators and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: One years from date of Substantial Completion, except as follows:

a. Manual Closers: 10 years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 HINGES, GENERAL

A. Quantity: Provide the following, unless otherwise indicated:

1. Two Hinges: For doors with heights up to 60 inches.
2. Three Hinges: For doors with heights 61 to 90 inches.
3. Four Hinges: For doors with heights 91 to 120 inches.
4. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

B. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

C. Hinge Base Metal: Unless otherwise indicated, provide the following:

1. Interior Hinges: Steel, with steel pin.
2. Hinges for Fire-Rated Assemblies: Steel, with steel pin.

D. Hinge Options: Where indicated in door hardware sets or on Drawings:

1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for outswinging exterior doors.

E. Fasteners: Comply with the following:

1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
2. Wood Screws: For wood doors and frames.
3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
4. Screws: Phillips flat-head; Finish screw heads to match surface of hinges.

2.2 LOCKS AND LATCHES, GENERAL

A. Accessibility Requirements: Comply with ANSI A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.

B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

C. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.
2. Deadbolts: Minimum 1-inch bolt throw.

D. Backset: 2-3/4 inches, unless otherwise indicated.

E. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:

1. Strikes for Bored Locks and Latches: BHMA A156.2.
2. Strikes for Auxiliary Deadlocks: BHMA A156.5.
3. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

2.3 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:

1. Bored Locks: BHMA A156.2.

B. Bored Locks: BHMA A156.2 Grade 1; Series 4000.

2.4 AUXILIARY LOCKS AND LATCHES

1. Auxiliary Locks: BHMA A156.5 Grade 1 unless Grade 2 is indicated.

2.5 DOOR BOLTS

A. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors.

1. Flush Bolt Heads: Minimum of 1/2-inch- diameter rods of brass, bronze, or stainless steel with minimum 12-inch- long rod for doors up to 84 inches in height. Provide longer rods as necessary for doors exceeding 84 inches.

B. Manual Flush Bolts: BHMA A156.16 Grade 1 designed for mortising into door edge.

C. Automatic and Self-Latching Flush Bolts: BHMA A156.3 Grade 1; designed for mortising into door edge.

2.6 LOCK CYLINDERS

A. Standard Lock Cylinders: BHMA A156.5, Grade 1 unless Grade 2 is indicated.

B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Number of Pins: Six.
2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
4. Bored-Lock Type: Cylinders with tailpieces to suit locks.

5. All cylinders to match existing keyway.

C. Construction Keying: Comply with the following:

1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

2.7 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:

1. Master Key System: Cylinders are operated by a change key and a master key.
2. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: "DO NOT DUPLICATE" and Keyset number.

2. Quantity: In addition to one extra key blank for each lock, provide the following:

a. Cylinder Change Keys: Three.
b. Master Keys: Five.
c. Grand Master Keys: Five.

2.8 CLOSERS

A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with ANSI A117.1.

1. Comply with the following maximum opening-force requirements:

a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
b. Sliding or Folding Doors: 5 lbf applied parallel to door at latch.
c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.

C. Power-Assist Closers: As specified in Division 08 Section "Automatic Door Operators" for access doors for people with disabilities or where listed in the door hardware sets.

D. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to

weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

E. Surface Closers: BHMA A156.4 Grade 1 Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.

F. Coordinators: BHMA A156.3.

2.9 PROTECTIVE TRIM UNITS

A. Size: 1-1/2 inches less than door width on push side and 1/2 inch less than door width on pull side, by height specified in door hardware sets.

B. Fasteners: Manufacturer's standard machine or self-tapping screws.

C. Metal Protective Trim Units: BHMA A156.6; beveled top and 2 sides; fabricated from material indicated in door hardware sets.

1. Material: 0.050-inch- thick stainless steel.

2.10 STOPS AND HOLDERS

A. Stops and Bumpers: BHMA A156.16 Grade 1 unless Grade 2 is indicated.

1. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.

B. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame.

2.11 DOOR GASKETING

A. Standard: BHMA A156.22.

B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

C. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UBC Standard 7-2.

1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.

D. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

E. Gasketing Materials: ASTM D 2000 and AAMA 701/702.

2.12 THRESHOLDS

A. Standard: BHMA A156.21.

B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with ANSI A117.1.

1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than [1/2 inch high.

C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch high.

2.13 MISCELLANEOUS DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16, Grade 1 unless Grade 2 is indicated.

2.14 FABRICATION

A. Manufacturer's Nameplate: Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where

through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Steel Machine or Wood Screws: For the following fire-rated applications:

   a. Mortise hinges to doors.
   b. Strike plates to frames.
   c. Closers to doors and frames.

3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:

   a. Surface hinges to doors.
   b. Closers to doors and frames.
   c. Surface-mounted exit devices.

4. Spacers or Sex Bolts: For through bolting of hollow metal doors.
5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.15 FINISHES

A. Standard: Comply with BHMA A156.18.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. BHMA Designations: Comply with base material and finish requirements indicated by the following:

1. BHMA 619: Satin nickel plated, clear coated, over brass or bronze base metal.
2. BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.
3. BHMA 627: Satin aluminum, clear coated, over aluminum base metal.
4. BHMA 628: Satin aluminum, clear anodized, over aluminum base metal.
5. BHMA 630: Satin stainless steel, over stainless-steel base metal.
6. BHMA 652: Satin chromium plated over nickel, over steel base metal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Frames: Comply with DHI A115 series.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
2. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

B. Six-Month Adjustment: Approximately six months after date of Substantial Completion, Installer shall perform the following:

1. Examine and readjust each item of door hardware as necessary to ensure function of doors and door hardware.
2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

END OF SECTION 08 71 00

Attachment: Finish Hardware Schedule

SECTION 088000

GLAZING

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. This Section includes glazing for:

1. Doors.

B. Related Sections:

1. Division 08 Section “Fiberglass Doors and Frames” for glazed exterior doors.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind loads without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:

a. Specified Design Wind Loads: As indicated on Drawings.
b. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.

1) For insulating glass.

c. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on

surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

C. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

D. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

B. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.8 WARRANTY

A. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.

D. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes enhanced-protection testing requirements in ASTM E 1996 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.

1. Small-Missile Test: For glazing located more than 30 feet above grade.
2. Large-Missile Test: For all glazing, regardless of height above grade.

E. Uniform Wind Load Capacity: Design, size and install components to withstand positive and negative wind loading pressures in accordance with International Building Code, as determined by Structural Engineer.

2.2 LAMINATED GLASS

A. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph in "Glass Products, General" Article, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written recommendations.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

2.3 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
2. Spacer: Manufacturer's standard spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or blend of both.

B. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated Glass" Article as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article.

2.4 GLAZING ACCESSORIES

A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other.

B. Glazing Sealants: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Dow Corning Corporation.
    b. GE Construction Sealants; Momentive Performance Materials Inc.
    c. Tremco Incorporated.

2. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

C. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

D. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.5 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.6 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 LAMINATED GLASS SCHEDULE

A. Windborne-Debris-Impact-Resistant Laminated Glass at 1st Floor Exterior Doors: Clear laminated glass with two plies of heat strengthened float glass.

1. Minimum Thickness of Each Glass Ply: 6 mm.
2. Interlayer Thickness: 0.060 inch.

3.9 INSULATING-GLASS SCHEDULE

A. Clear, Windborne-Debris-Impact Resistant Insulating-Glass Units at 2nd Floor Exterior Doors:

1. Description: Dual-seal impact-resistant insulating glass.
2. Overall Unit Thickness: 1 inch
3. Outdoor Lite: (2) laminated lites of heat-strengthened (HS) float glass, ASTM C 1036, Type 1, Class 1, Quality q3; clear.
4. Interspace Content: Air, hermetically sealed, dehydrated space.
5. Indoor Lite: Heat-strengthened (HS) float glass; ASTM C 1036, Type 1, Class 1, Quality q3; clear.
6. Interlayer Material: Polyvinyl Butyral (PVB) or SGP
7. Interlayer Color: Clear

END OF SECTION 08 80 00

SECTION 08 83 00

MIRRORS

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. This Section includes the following types of silvered flat glass mirrors.

1. Mirrors.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.

C. Samples: For each type of the following products:

1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
2. Mirror Clips: Full size.
3. Mirror Trim: 12 inches long.

D. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.

E. Maintenance Data: For mirrors to include in maintenance manuals.

F. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

D. Glazing Publications: Comply with the following published recommendations:

1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."

E. Safety Glazing Products: For film-backed mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

F. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing film and substrates on which mirrors are installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide mirrors by one of the following:

1. Arch Aluminum & Glass Co., Inc.
2. Binswanger Mirror.
3. Guardian Industries Corp.
4. Independent Mirror Industries, Inc.
5. Lenoir Mirror Company.
6. Stroupe Mirror Co., Inc.
7. Sunshine Mirror.
8. Virginia Mirror Company, Inc.
9. Walker Glass Co., Ltd.

2.2 SILVERED FLAT GLASS MIRROR MATERIALS

A. Clear Glass Mirrors: ASTM C 1503, Mirror Select Quality.

1. Nominal Thickness: 6.0 mm.

2.3 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Type A Shore durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Gunther Mirror Mastics.
b. Palmer Products Corporation.

2.4 MIRROR HARDWARE

A. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.

1. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.05 inch.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Laurence, C. R. Co., Inc.; CRL Standard "J" Channel.
2) Sommer & Maca Industries, Inc.; Aluminum Shallow Nose "J" Moulding Lower Bar.
3) Sommer & Maca Industries, Inc.; Heavy Gauge Aluminum Shallow Nose "J" Moulding Lower Bar.

2. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.062 inch.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Laurence, C. R. Co., Inc.; CRL Deep "J" Channel.
2) Sommer & Maca Industries, Inc.; Aluminum Deep Nose "J" Moulding Upper Bar.
3) Sommer & Maca Industries, Inc.; Heavy Gauge Aluminum Deep Nose "J" Moulding Lower Bar.

3. Finish: Clear bright anodized.

B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

C. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.5 FABRICATION

A. Mirror Sizes: To suit Project conditions, and before tempering, cut mirrors to final sizes and shapes.

B. Cutouts: Fabricate cutouts before tempering for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Rounded polished edge.

1. Seal edges of mirrors after edge treatment to prevent chemical or atmospheric penetration of glass coating.
2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance.

1. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
2. Proceed with mirror installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating surfaces with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Provide a minimum air space of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

1. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
2. Install mastic as follows:

    a. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.

3.4 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

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. This Section includes non-load-bearing steel framing members for the following applications:

1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

PART 2 - PRODUCTS

2.1 NON-LOAD-BEARING STEEL FRAMING, GENERAL

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized, unless otherwise indicated.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steel Framing and Furring:

a. Steel Stud Manufacturers' Association members.
b. Dietrich UltraSTEEL™ Framing.

2.2 SUSPENSION SYSTEM COMPONENTS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.

B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.

1. Depth: 2 inches, unless otherwise indicated.

D. Furring Channels (Furring Members):

1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base Metal Thickness: 0.0179 inch.

E. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.

1. Minimum Base-Metal Thickness: 0.027 inch (25 gauge or equivalent), or greater as required to comply with manufacturer's requirements for limiting heights and applied loads.
2. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Steel Network Inc. (The); VertiClip SLD Series.
2) Superior Metal Trim; Superior Flex Track System (SFT).

C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing at all loctions where wall-mounted accessories are shown and at Owner-installed visual display board locations.

1. Minimum Base-Metal Thickness: 0.0312 inch.

D. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges.

1. Depth: 1-1/2 inches, unless indicated otherwise.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: 0.0179 inch.
2. Depth: 7/8 inch.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Install sealer gaskets to isolate the underside of wall bottom track and the top of slab-on-grade at stud locations.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.

1. Space studs as follows: 16 inches o.c., unless otherwise indicated.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb, unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

D. Direct Furring:

1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

E. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION 09 22 16

SECTION 09 24 23

CEMENT STUCCO SYSTEM

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 materials and installation of trowel applied air barrier membrane and stucco over vertical above grade concrete and concrete masonry walls.

B. Related Requirements:

1. Section 03 30 00: Cast-In-Place Concrete
2. Section 04 22 00: Concrete Unit Masonry
3. Section 07 92 00: Joint Sealants

1.3 DEFINITIONS

A. Air Barrier Material: A primary element that provides a continuous barrier to the movement of air.

B. Air Barrier Accessory: A transitional component of the air barrier that provides continuity.

C. Air Barrier Auxiliary Material: A transitional component that provides air barrier continuity furnished by a source other than the primary air barrier manufacturer.

D. Air Barrier Assembly: The collection of air barrier materials, accessory and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference

1. Review air barrier and stucco installation requirements and installation details, mock-ups, testing requirements, protection, and sequencing of work.

1.5 REFERENCES

A. ASTM Standards

D 4541-09	Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
E 96-00	Test Method for Water Vapor Transmission of Materials

E 283-04 (2012)	Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
E 330-14	Test Method for Structural Performance of Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
E 331- 00 (2009)	Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
E 779-10	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
E 783-02	Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
E 1186-03 (2009)	Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
E 1827-96 (2007)	Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
E 2178-03	Test Method for Air Permeance of Building Materials

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)

2005 ASHRAE Handbook – Fundamentals

ASHRAE 90.1	2010, Energy Standard for Buildings Except Low-Rise Residential Buildings

C. South Coast Air Quality Management District (SCAQMD)

Rule 1113 (2007)	Architectural Coatings

1.6 COORDINATION/SCHEDULING

A. Provide minimum 28 day cure of concrete and concrete masonry units before the installation of air barrier and stucco components.

B. Sequence work such that placement of stucco, stucco primers and finish coats closely follow air barrier installation (90 days maximum between coats) to prevent surfaces from being contaminated by atmospheric conditions, dust, dirt, salts, trades, or other sources of surface contamination.

C. Commence the stucco installation after completion of all floor, roof construction and other construction that imposes dead loads on the wall to prevent excessive deflection (and potential cracking) of the stucco.

D. Provide site grading such that stucco terminates above earth grade minimum 4 inches and above finished grade (pavers/sidewalk) minimum 2 inches. Provide increased clearance in freeze/thaw climate zones.

E. Coordinate installation of foundation waterproofing, roofing membrane, windows, doors and other wall penetrations to provide a continuous air barrier.

F. Install primary air barrier before installing stucco accessories.

G. Provide protection of rough openings before installing windows, doors, and other penetrations through the wall.

H. Provide sill flashing before windows and doors are installed to direct water beyond the finished exterior wall surface.

I. Install window and door head flashing immediately after windows and doors are installed.

J. Install diverter flashings wherever water can enter the assembly to direct water beyond the finished exterior wall surface.

K. Install sealants and flashings as indicated to prevent water entry into the wall assembly immediately after installation of stucco and after finish coatings are dry. Do not install sealant against stucco finish coat in dynamic joint conditions.

L. Attach penetrations through stucco into structural support and provide water tight seal at penetrations.

1.7 SUBMITTALS

A. Manufacturer's specifications, details and product data.

B. Manufacturer's standard warranty.

C. Samples for approval as directed by architect or owner.

D. Shop drawings: substrate joints, cracks, flashing transitions, penetrations, corners, terminations, and tie-ins with adjoining construction, interfaces with separate materials that form part of the air barrier and stucco wall assembly.

1.8 QUALITY ASSURANCE

A. Manufacturer requirements

1. Manufacturer of exterior wall air barrier materials for a minimum of 20 years in North America.

2. ISO 9001:2008 Certified Quality System and ISO 14001:2004 Certified Environmental Management System

B. Contractor requirements

1. Knowledgeable in the proper use and handling of materials.

2. Employ skilled mechanics who are experienced and knowledgeable in waterproofing, air barrier, and stucco application, and familiar with the requirements of the specified work.

3. Provide the proper equipment, manpower and supervision on the job-site to install the air barrier, WRB, and stucco assembly in compliance with the project plans & specifications, shop drawings, and manufacturer's published specifications and details.

C. Regulatory Compliance

1. Primary air barrier material:

a. Comply with VOC requirements of SCAQMD Rule 1113.

b. Comply with allowable air leakage requirements of ASHRAE 90.1 – 2010

c. Comply with IRC, IBC, and IECC – 2012

2. Stucco brown coat

a. As listed in ICC ESR 2323 or ICC ESR 1240

D. Mock-ups

1. Build stand-alone site mock up or sample wall area on as-built construction to incorporate back-up wall construction, typical details covering substrate joints, cracks, flashing transitions, penetrations, corners, terminations, tie-ins with adjoining construction, and interfaces with separate materials that form part of the air barrier and stucco wall assembly. Apply air barrier and scratch coat, stucco brown coat, and stucco primer and finish coat consistent with specified materials and methods of construction. For stucco wall assemblies applied directly to concrete build full assembly for field adhesion tests as determined by Architect.

1.9 TESTING

A. Conduct site testing by qualified test agency or building envelope consultant as directed by Architect

1. Construct full-scale mock-up of typical stucco/window wall assembly with specified tools and materials and test air and water infiltration and structural performance in accordance with ASTM E 283, ASTM E 331 and ASTM E 330, respectively, through independent laboratory. Mock-up shall comply with requirements of project specifications. Where mock-up is tested at job site maintain approved mock-up at site as reference standard. If tested off-site accurately record construction detailing and sequencing of approved mock-up for replication during construction.

2. Conduct assembly air leakage testing in accordance with ASTM E 783.

3. Conduct adhesion testing to substrates in accordance with ASTM D 4541.

4. Conduct wet sealant adhesion testing in accordance with sealant manufacturer's field quality control test procedure.

5. Conduct pH testing to check stucco surface alkalinity before application of primer or finish materials. Where alkaline resistant primer is used pH testing may be waived.

6. Notify Architect minimum 7 days prior to testing.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product.

B. Protect coatings (pail products) from freezing temperatures and temperatures in excess of 90 degrees F. Store away from direct sunlight.

C. Protect portland cement-based materials (bag products) from moisture and humidity. Store under cover off the ground in a dry location.

D. Protect and store accessory and auxiliary products in accordance with manufacturer's written instructions.

1.11 PROJECT/SITE CONDITIONS

A. Maintain ambient and surface temperatures above 40 degrees F and below 100 degrees F, during application and drying period, minimum 24 hours after application of materials.

B. Provide supplementary heat for installation in temperatures less than 40 degrees F or if surface temperature is likely to fall below 40 degrees F.

C. Provide protection of surrounding areas and adjacent surfaces from application of materials.

1.12 WARRANTY

A. Provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products by **Sto Corp.** or Architect approved comparable manufacturer.

B. Obtain primary air barrier, accessory air barrier materials, stucco, stucco primer and finish coat from single source.

2.2 MATERIALS

A. Primary Air Barrier Material: Sto ExtraSeal – single component polymer modified portland cement-based air barrier membrane material.

B. Accessory Materials

1. Joint and Rough Opening Treatments
    a. Sto ExtraSeal with Sto Detail Mesh
    b. StoGuard RapidSeal (for wood bucks)
2. Joint and Rough Opening Reinforcement
    a. Sto Detail Mesh: nominal 4.2 oz/yd^2 self-adhesive, flexible, symmetrical, interlaced glass fiber reinforcing mesh, with alkaline resistant coating for compatibility with Sto materials.
3. Transition Membrane
    a. StoGuard Transition Membrane: flexible air barrier membrane for continuity at transitions – sheathing to foundation, dissimilar materials (CMU to frame wall), wall to balcony floor slab or ceiling, flashing shingle lap transitions, floor line deflection joints, masonry control joints, and through wall joints in masonry or frame construction.

C. Auxiliary Materials

1. Wet sealant: Dow Corning 790, 791, and 795 sealants

2. Pre-cured sealant tape: Dow 123

3. Spray foam:

a. Sto TurboStick Adhesive

b. Dow Great Stuff for Gaps and Cracks

D. Patching and Leveling Material for Prepared Concrete and Masonry

1. Sto ExtraSeal: polymer modified cement-based patch and leveling material for applications up to 1/8 inch in in depth.

2. Sto BTS Xtra: lightweight polymer modified cement-based patch and leveling material for applications up to 1/4 inch in depth

3. Sto Leveler: polymer modified cement-based patch and leveling material for applications up to 1/4 inch in depth.

E. Stucco

1. 102 StoPowerwall Stucco Pre-Blended: fiber reinforced one coat portland cement stucco pre-blended with graded sand, and in compliance with ICC AC 11. See ICC ESR 2323.

F. Stucco Primers

1. Sto Hot Prime – acrylic based primer/sealer for freshly placed (minimum 4 day old) and high pH stucco surfaces.

G. Stucco Finish

1. Sto Powerflex textured finish; texture as selected and approved by Architect on basis of job site installed mock-ups.

2.3 PERFORMANCE REQUIREMENTS (AIR BARRIER)

A. Water penetration resistance: comply with ICC ES AC 212, par 4.8.3, no water penetration after 5 hours hydrostatic pressure

B. Adhesion: ASTM D 4541, $\geq$ 50 psi on prepared CMU substrates

C. Water vapor permeance: ASTM E 96 Method B, minimum 20 perms

D. Air permeance: ASTM E 2178, $\leq$ 0.004 cfm/ft^2 air leakage at 1.57 psf

E. Field adhesion testing: ASTM D 4541, strength requirements as dictated by Architect based on exposure conditions such as building height, orientation, climate, and building design

F. Building envelope air leakage: ASTM E 779 or 1827, $\leq$ 0.4 cfm/ft^2

G. Volatile Organic Compounds: SCAQMD Rule 1113, primary air barrier material, < 50 g/L

2.4 DESIGN CRITERIA

A. Structural (Wind and Axial Loads)

1. Design for maximum allowable deflection normal to the plane of the wall: L/360

2. Design for wind load in conformance with code requirements.

B. Moisture Control

1. Prevent the accumulation of water in the wall assembly and behind the exterior wall cladding:

   a. Minimize condensation within the assembly.

   b. Drain water directly to the exterior where it is likely to penetrate components in the wall assembly (windows and doors, for example).

   c. Provide corrosion resistant flashing to direct water to the exterior in accordance with code requirements, including: above window and door heads, beneath window and door sills, at roof/wall intersections, floor lines, decks, intersections of lower walls with higher walls, and at the base of the wall.

   d. Air Leakage Prevention – prevent excess air leakage in the design and detailing of the wall assembly. Provide continuity between air barrier components in the wall assembly.

   e. Vapor Diffusion and Condensation – perform a dew point analysis of the wall assembly to determine the potential for accumulation of moisture in the wall assembly as a result of water vapor diffusion and condensation. Adjust wall assembly components accordingly to minimize the risk of condensation. Avoid the use of vapor retarders on the interior side of the wall in warm, humid climates.

   f. Protect rough openings with StoGuard rough opening treatment extended no further than the stucco termination accessory expanded flange (as stucco will not adhere to StoGuard rough opening treatments). Refer to manufacturer's details.

   g. Where casing bead is used back-to-back at expansion joints, back joints with appropriate StoGuard Transition Membrane. Refer to manufacturer's details.

   h. Seal accessory butt joints with sealant.

C. Air Barrier Continuity: provide continuous air barrier assembly of compatible air barrier components.

D. Substrates

1. Provide surface plane tolerance not to exceed ¼ inch in 10 feet.

2. Remove form ties, trim projecting concrete and fill honeycombs or other surface defects with appropriate patch and repair material.

3. Concrete – provide for removal of form oil, curing compounds, efflorescence, coatings, salts, or other surface contamination, laitance or other surface conditions that could interfere with adhesion. Provide an absorbent surface, slightly scarified or with surface roughness, or both (refer to Section 3.2A1).

4. Concrete Masonry – provide open texture concrete masonry units with flush joints, free of efflorescence, coatings, salts, or other surface contamination, weak surfaces or other surface conditions that could interfere with adhesion (refer to Section 3.2B1).

5. Do not install air barrier, stucco, primers or finishes over efflorescence, laitance or weak surface conditions, painted, coated, salt-contaminated, non-absorbent, smooth, or high density concrete surfaces, or any concrete or CMU substrate where adhesion is in question, or when total stucco thickness (including finish coat) will exceed 5/8 inch (16 mm). Use appropriate metal plaster base in these cases.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect concrete and concrete masonry surfaces for:

1. Contamination – algae, dirt, dust, efflorescence, form oil, fungus, grease, mildew or other foreign substances.

2. Surface deficiencies – weak, friable, chalkiness, laitance, bugholes, honeycombs, and spalls.

3. Cracks – measure crack width and record location of cracks.

4. Damage or deterioration.

5. Moisture damage – record any areas of moisture damage or excess moisture.

B. Report deviations from the requirements of project specifications or other conditions that might adversely affect the air barrier installation. Do not start work until deviations are corrected.

3.2 SURFACE PREPARATION

A. Concrete

1. Remove form ties and trim projecting concrete so it is even with the plane of the wall. Fill honeycombs or other surface defects with compatible patch and repair material. Remove form release agents or other surface contamination by chemical or mechanical means. Provide a surface that is structurally sound, free of laitance and other surface defects, absorbent, and slightly scarified or with surface roughness, or both. Ensure that the surface is structurally sound and free of all dust, dirt, grease, efflorescence, coatings, salts or other surface contamination before proceeding with work. Ensure that the surface is sufficiently absorbent and roughened for adequate adhesion. Pre-moisten highly absorbent surfaces with water just prior to placement of air barrier, especially during hot, dry conditions. Verify adhesion with load tests after air barrier/stucco assembly has fully cured (28 days) on mock-up wall, and throughout the project as directed in 1.9, Testing.

B. Concrete Masonry Units

1. Remove projecting joint mortar so it is even with the plane of the wall. Remove surface contaminants such as efflorescence, existing paint or coatings, or any other surface contamination by chemical or mechanical means. Pre-moisten the surface with water just prior to placement of air barrier. Verify adhesion with load tests after stucco/air barrier assembly has fully cured (28 days) on mock-up wall, and throughout the project as directed in 1.9, Testing.

C. Where bond inhibiting material cannot be removed, where concrete or masonry surface irregularities are such that more than 5/8 inch (16 mm) of stucco (including Sto ExtraSeal skim coat and scratch coat, stucco, and stucco finish) must be applied, or where the surface is too smooth, dense, or non-absorbent to receive the air barrier or stucco components, install furred or self-furred lath as specified by the Architect. Verify adequacy of lath attachment with respect to design wind pressures. Do not install stucco over unprepared substrates or any substrate where adhesion is in question. (Note: in these cases Sto ExtraSeal air barrier may be installed over the stucco brown coat with proper integration of other air barrier materials).

D. Repair cracks up to 1/8 inch (3 mm) wide by raking with a sharp tool to remove loose, friable material and blow clean with oil-free compressed air. Apply joint reinforcement material centered over crack, then apply Sto ExtraSeal with a trowel, drywall or putty knife to cover the reinforcement.

3.3 INSTALLATION

A. Coordinate work with other trades to ensure air barrier continuity with connections at foundation, floor lines, flashings, lintels and shelf angles, openings and penetrations such as pipes, vents, windows and doors, masonry anchors, rafters or beams, joints in construction, projections such as decks and balconies, and roof line.

B. Install materials only when surface and ambient temperature are minimum 40 degrees F (4 degrees C) and rising during application and drying period and below 100 degrees F (38 degrees C). Install air barrier material to dry or damp surfaces (no standing or glistening water).

C. Rough opening protection:

1. Apply Sto Detail Mesh into the opening as indicated on detail drawings. Embed the mesh in Sto ExtraSeal applied by spray or trowel at approximately 1/16 – 1/8 inch (1.6-3 mm) thick. “Knock down” spray applications to produce a void and pinhole free surface. Overlap mesh seams minimum 2-1/2 inches (63.5 mm). Limit extension of Sto ExtraSeal to limit of expanded flange accessories. Provide slope to shed water at the sill. Refer to Sto Guide Detail 65c.25.

2. For openings with wood bucks install StoGuard RapidSeal over wood buck and lap onto Sto ExtraSeal minimum 2 inches (51 mm). Do not install stucco over StoGuard RapidSeal. Limit extension of StoGuard RapidSeal to limit of expanded flange accessories. Refer to Sto Guide Detail 65c.25.

D. Air barrier membrane

1. Concrete – install one coat of Sto ExtraSeal by spray or trowel in a uniform, continuous application at 1/16-1/8 inch (1.6-3 mm) thick. “Knock down” spray applications with a trowel. Do not install over working or moving joints or joint sealants. .

2. Concrete Masonry

    a. Install one liberal coat of Sto ExtraSeal in a uniform, continuous application by spray or trowel at 1/16 – 1/8 inch (1.6-3 mm) thick. “Knock down” spray applications with a trowel. Surface must be free of voids and pinholes when dry. Final application must not show CMU surface texture or joints. Do not install over working or moving joints or joint sealants.

E. Transitions

1. Install air barrier accessory material or auxiliary material at transition areas: foundation, floor lines, flashings, lintels and shelf angles, openings and penetrations such as pipes, vents, windows and doors, masonry anchors, rafters or beams, joints in construction, projections such as decks and balconies, and roof line. Refer to Sto Guide Details 65c.xx. Limit extension of transistion materials to limit of expanded flange accessories at stucco terminations.

F. Stucco Accessories

1. Install stucco accessories – casing beads, expansion and control joints – over air barrier with appropriate fasteners into supporting construction as required by ASTM C 926.

G. Scratch Coat and Brown Coat

1. Scratch coat: apply an approximate 3/8 inch (9 mm) scratch coat of Sto ExtraSeal by spray or trowel any time after the air barrier application is dry. Rake the surface horizontally with a ¼ x 3/8 x ¼ inch (6 x 9 x 6 mm) tile setter’s notched trowel to produce discrete horizontal ribbons. Do not moist cure the scratch coat.

2. Brown coat: allow scratch coat to dry minimum 24 hours and install StoPowerwal (ICC ESR 2323) stucco brown coat in accordance with applicable codes and manufacturer’s requirements. DO NOT APPLY BY PUMP OR SPRAY. Limit total thickness, including Sto ExtraSeal skim coat and scratch coat, stucco brown coat, and allowance for finish coat, to 5/8 inches (16 mm) maximum.

H. Primer Installation

1. Sto Hot Prime – Moist cure stucco brown coat for a minimum of 48 hours. Allow stucco to dry an additional 48 hours, then apply primer evenly with brush, roller or proper spray equipment over the clean, dry stucco and foam build-outs, and allow to dry. Age of stucco must be minimum 7 days before application of finish.

I. Finish Installation

1. Apply finish to primed stucco and foam build-outs when dry. Apply finish by spraying or troweling with a stainless steel trowel, depending on the finish specified. Follow these general rules for application of finish:

    a. Allow 28 day stucco age or check for pH < 10 before applying finish. If Sto Hot Prime is used, allow minimum 7 day age of stucco.

    b. Avoid application in direct sunlight.

    c. Apply finish in a continuous application, and work a wet edge towards the unfinished wall area. Work to an architectural break in the wall before stopping to avoid cold joints.

    d. Weather conditions affect application and drying time. Hot or dry conditions limit working time and accelerate drying. Adjustments in the scheduling of work may be required to achieve desired results; cool or damp conditions extend working time and retard drying and may require added measures of protection against wind, dust, dirt, rain and freezing. Adjust work schedule and provide protection.

    e. Do not install separate batches of finish side-by-side.

    f. Do not apply finish into or over sealant joints or joint accessories. Apply finish to outside face of wall only.

    g. Do not apply finish over irregular, high pH, or unprepared surfaces, or surfaces not in compliance with the requirements of the project specifications.

3.4 FIELD QUALITY CONTROL

A. Owner's qualified testing agency or building envelope consultant shall perform inspections and tests.

B. Inspections: air barrier materials are subject to inspection to verify compliance with requirements.

1. Condition of substrates and substrate preparation.

2. Installation of primary air barrier material, accessory materials, and compatible auxiliary materials over structurally sound substrates and in conformance with architectural design details, contractor's shop drawings, project mock-up, and manufacturer's written installation instructions.

3. Air barrier continuity and connections without gaps and holes at foundation, floor lines, flashings, lintels and shelf angles, openings and penetrations such as pipes, vents, windows and doors, masonry anchors, rafters or beams, joints in construction, projections such as decks and balconies, and roof line.

C. Tests: air barrier materials and assembly are subject to tests to verify compliance with performance requirements:

1. Qualitative air leakage test: ASTM E 1186

2. Quantitative air leakage test: ASTM E 779, ASTM E 783, and ASTM E 1827

3. Adhesion test: ASTM D 4541

4. Qualitative adhesion and compatibility testing: wet sealant manufacturer's field quality control adhesion test

D. Repair non-conforming substrates and air barrier material installation to conform with project requirements.

E. Take corrective action to repair and replace, or reinstall materials, seal openings, gaps, or other sources of air leakage to conform with project performance requirements.

3.5 PROTECTION

A. Provide protection of installed materials from water infiltration into or behind them.

B. Provide protection of installed materials from dust, dirt, salts, or other surface contamination, precipitation, and freezing.

C. Provide protection of installed primer and finish from dust, dirt, salts, precipitation, freezing and continuous high humidity until fully dry.

3.6 CLEANING, REPAIR AND MAINTENANCE

A. Clean and maintain the stucco finish for a fresh appearance and to prevent water entry into and behind the stucco. Repair cracks, impact damage, spalls or delamination promptly.

B. Maintain adjacent components of construction such as sealants, joints in construction, windows, doors, and flashing, to prevent water entry into the wall assembly.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

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. This Section includes the following:

1. Interior gypsum board.
2. Sound dampening board.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.4 STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 INTERIOR GYPSUM BOARD

A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. G-P Gypsum.
    b. Lafarge North America Inc.
    c. National Gypsum Company.
    d. USG Corporation.

B. Type X:

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

C. Moisture- and Mold-Resistant Type: ASTM C1177/C 1177M. Non-combustible, moisture- and mold-resistant gypsum core with coated fiberglass mat facings.

1. Thickness: 5/8-inch thick.
2. Long Edges: Tapered.
3. Products: Subject to compliance with requirements, provide one of the following:

    a. G-P Gypsum Company; DensArmor Plus Abuse Guard Interior Drywall.
    b. United States Gypsum Co.; FIBEROCK Brand Aqua-Tough Gypsum Panels.

2.2 SOUND DAMPENING MATERIALS

A. Sound Deadening Board: Glass faced gypsum board with sound-absorbing viscoelastic polymer core.

1. Product: Subject to compliance with requirements, provide the following:

    a. "QuietRock 528" by Serious Energy.

2. Thickness: 5/8 inch thick.
3. Tolerance: +/- 0.650-0.715".
4. STC Rating: 50-58 (ASTM E90).
5. Water Absorption: < 5% of weight (ASTM C630, ASTM C1396, ASTM C1658).
6. Mold Resistance: 10, in a test as manufactured (ASTM D3273).
7. Size: 48 by 96 inches.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Paper-faced galvanized steel sheet.
2. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. Expansion (control) joint.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.
2. Glass-Mat Faced Gypsum Board: 10-by-10 glass mesh.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

D. Joint Compound for Glass-Mat Faced Gypsum Board Applications:

1. Glass-Mat Gypsum Board: As recommended by board manufacturer.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

D. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."

E. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

C. Locate edge and end joints over supports. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

D. Form control and expansion joints with space between edges of adjoining gypsum panels.

E. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

F. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Type X: Vertical surfaces, unless otherwise indicated.
2. Glass-Mat Interior Type: At Bathrooms.
3. Sound Dampening Materials: Where indicated on Drawings.

B. Single-Layer Application:

1. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

2. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners, unless otherwise indicated.
2. LC-Bead: Use at exposed panel edges.

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.

3.6 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

SECTION 09 30 00

TILING

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. This Section includes the following:

1. Interior wall and floor tile.

B. Related Sections:

1. Section 09 29 00 "Gypsum Board" for moisture- and mold-resistant gypsum board substrate.

1.3 PERFORMANCE REQUIREMENTS

A. Static Coefficient of Friction: For tile installed on floor surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level Surfaces: Minimum 0.6.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.

D. Product Certificates: For each type of product, signed by product manufacturer.

E. Material Test Reports: For each tile-setting and -grouting product.

1.5 QUALITY ASSURANCE

A. Source Limitations for Tile: Obtain all tile of same type from one source or producer.

1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquid latexes in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.

C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures,

patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

1. As selected by Architect from manufacturer's full range.

2.2 TILE PRODUCTS

A. Porcelain Floor Tile: Flat tile, as follows:

1. Composition: Porcelain.
2. Module Size: As selected by Architect.
3. Face: Plain with square or cushion edges.

B. Wall Tile: Flat tiles, as follows:

1. Module Size: As selected by Architect.
2. Face: Plain with modified square edges or cushion edges.
3. Finish: As selected by Architect.

C. Wall Tile Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes as selected by Architect.

1. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
2. External Corners: Surface bullnose, module size same as adjoining flat tile.
3. Internal Corners: Field-butted square corners.

D. Accessories: Provide vitreous china accessories of type and size indicated, suitable for installing by same method as used for adjoining wall tile.

1. One soap holder for each shower and tub indicated.
2. Color and Finish: Match adjoining wall tile.

2.3 SETTING AND GROUTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.1A.

B. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.

C. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.

D. High-Performance Tile Grout: ANSI A118.7.

2.4 MISCELLANEOUS MATERIALS

A. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.5 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.

B. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION, GENERAL

A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.

B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.

E. Grout tile to comply with requirements of the following tile installation standards:

1. For ceramic tile grout (latex-portland cement), comply with ANSI A108.10.

3.4 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove latex-portland cement grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.5 TILE INSTALLATION SCHEDULE

A. Interior Wall Installations:

1. Tile Installation W243: Thin-set mortar on gypsum board; TCA W243.

a. Tile Type: As selected by Architect.
b. Thin-Set Mortar: Latex- portland cement mortar.
c. Grout: High-performance unsanded grout.

END OF SECTION 09 30 00

SECTION 095113

ACOUSTICAL PANEL CEILINGS

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. This Section includes acoustical panels and exposed suspension systems for ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch- long Samples of each type, finish, and color.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.

D. Maintenance Data: For finishes to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system through one source from a single manufacturer.

B. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:

C. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:

1. International Building Code, 1621.1, and applicable requirements of ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9.6.
2. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."

D. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.7 COORDINATION

A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANELS, GENERAL

A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.

B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.2 MINERAL-BASE ACOUSTICAL PANELS:

A. Manufacturers:

1. Armstrong World Industries; “Dune” Item No. 1772 (Basis of Design).
2. USG Corporation.

B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:

1. Type and Form: Type III, mineral base with painted finish; Form 2.
2. Pattern: CE.

C. Color: White.

D. Edge Detail: Square.

E. Thickness: 5/8 inch.

F. Size: 24 by 24 inches.

G. LR: Not less than 0.80.

H. NRC: Not less than 0.50.

I. Fire Rating: Class A.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
3. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.

E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

F. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

G. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.

H. Hold-Down Clips: At Exterior Drive-through, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.

2.4 METAL SUSPENSION SYSTEM:

A. Manufacturers:

1. Armstrong World Industries, Inc.; “Prelude XL 15/16” Exposed Tee System” (Basis of Design)
2. USG Corporation.

B. Wide-Face, Capped, Double-Web, Hot-Dip Galvanized-Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet hot-dip galvanized according to ASTM A 653/A 653M, with prefinished 15/16-inch- wide metal caps on flanges.

1. Structural Classification: Heavy-duty system.
2. Face Design: Flush face.
3. Cap Finish: Painted white.

2.5 METAL EDGE MOLDINGS AND TRIM

A. Manufacturers:

1. Armstrong World Industries, Inc.
2. Chicago Metallic Corporation.
3. USG Interiors, Inc.

B. Roll-Formed Sheet-Metal Edge Moldings and Trim: Provide perimeter trim, designed to fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

C. Beam End Retaining Clips: As approved by authority having jurisdiction, provide beam end retaining clips for perimeter attachment of suspension systems indicated; formed

from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

1. ACM7 by USG.
2. BERC-2 by Armstrong.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION, GENERAL

A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Standards for Ceiling Suspension Systems Requiring Seismic Restraint:
    a. CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies-Seismic Zones 3 & 4."
    b. IBC, 1621.1, and applicable requirements of ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9.6.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet . Miter corners accurately and connect securely.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 13

SECTION 09 65 13

RESILIENT BASE AND ACCESSORIES

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. Resilient base.

B. Related Sections:

1. Division 09 Section "Resinous Flooring" for resinous flooring.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products by **Johnsonite, Inc.** or Architect approved comparable product.

B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).

1. Group: I (solid, homogeneous).
2. Style: Style B, Cove.

C. Thickness: 0.125 inch.

D. Height: As indicated on Drawings.

E. Lengths: Cut lengths 48 inches long or coils in manufacturer's standard length.

F. Corners: Preformed.

G. Colors: As selected by Architect from full range of industry colors.

2.2 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until they are same temperature as the space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

D. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Perform the following operations immediately after completing resilient product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 09 65 13

SECTION 09 67 23

RESINOUS FLOORING

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. This Section includes resinous flooring systems with epoxy.

1. Application Method: Self-leveling slurry with broadcast flakes.

B. Related Work:

1. Division 09 Section "Resilient Base and Accessories" for rubber base.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.

C. Product Schedule: Use resinous flooring designations indicated in Part 2 and room designations indicated on Drawings in product schedule.

D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

E. Material Test Reports: For each resinous flooring component.

F. Material Certificates: For each resinous flooring component, signed by manufacturer.

G. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record

of successful in-service performance, and who is acceptable to resinous flooring manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply full-thickness mockups on 48-inch- square floor area selected by Architect.
2. Simulate finished lighting conditions for Architect's review of mockups.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 RESINOUS FLOORING (at Second Floor)

A. Basis-of-Design Products: Subject to compliance with requirements, provide **Stontec UTF by Stonhard, Inc.** or comparable product by one of the following:

1. BASF Construction Chemicals, Inc.

2. Crossfield Products Corp., Dex-O-Tex.
3. Dur-A-Flex Inc.
4. Valspar Flooring Division.

B. System Characteristics:

1. Color and Pattern: As selected by Architect from manufacturer's full range.
2. Wearing Surface: Manufacturer's standard smooth texture.
3. Overall System Thickness: 1/8 inch, or as recommended by manufacturer.

C. System Components: Manufacturer's standard components that are compatible with each other and as follows:

1. Body Coat:

a. Resin: Urethane.
b. Application Method: Self-leveling slurry with broadcast aggregates.

2. Aggregates: Colored quartz (ceramic-coated silica) flakes.
3. Non-Slip Aggregate for Exterior Porch: Natural silica or as otherwise recommended by manufacturer for non-slip application.
4. Primer: Type recommended by manufacturer for substrate and body coat indicated.
5. Topcoat: Urethane finish coat.

D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Tensile Strength: 2200 per ASTM D 638.
2. Impact Resistance: 160 in.lbs. per ASTM D 4226.
3. Abrasion Resistance: 0.03 gm max. weight loss per ASTM D 4060.
4. Flexural Strength: 2000 psi per ASTM D 790.
5. Hardness: 60, Shore D per ASTM D 2240.

2.2 RESINOUS FLOORING (at Equipment Room)

A. Basis-of-Design Products: Subject to compliance with requirements, provide **Stonchem 800 by Stonhard, Inc.** or comparable product by one of the following:

1. BASF Construction Chemicals, Inc.
2. Crossfield Products Corp., Dex-O-Tex.
3. Dur-A-Flex Inc.
4. Valspar Flooring Division.

B. System Characteristics:

1. Color and Pattern: As selected by Architect from manufacturer's full range.
2. Wearing Surface: Manufacturer's standard texture.
3. Overall System Thickness: 25 mils, nominal.

C. System Components: Manufacturer's standard components that are compatible with each other and as follows:

1. Body Coat: Highly cross-linked, vinyl ester lining system.

    a. Number of Coats: Two.

2. Primer: Type recommended by manufacturer for substrate and body coat indicated.

D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Tensile Strength: 2400 per ASTM D 638.
2. Abrasion Resistance: 0.10 gm max. weight loss per ASTM D 4060.
3. Flexural Strength: 6100 psi per ASTM D 790.
4. Hardness: 85 - 90, Shore D per ASTM D 2240.

2.3 ACCESSORY MATERIALS

A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

B. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:

    a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
    b. Comply with ASTM C 811 requirements, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.
3. Verify that concrete substrates are dry.

    a. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations.

3.2 APPLICATION

A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
3. At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.

    a. Apply joint sealant to comply with manufacturer's written recommendations.

B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Treat substrate cracks in accordance with manufacturer’s recommendations.

D. Apply self-leveling slurry body coat in thickness indicated for flooring system.

1. If aggregates are not part of a one-coat system, broadcast aggregates and, after resin is cured, remove excess aggregates to provide surface texture indicated.
2. Apply second body coat within 24 hours of first body coat, and apply second broadcast of aggregates. Scrape, sand and perform final vacuum.

E. Apply topcoat as recommended in writing by manufacturer.

F. Apply non-slip aggregates at exterior 2nd floor porch according to manufacturer’s recommendations.

3.3 FIELD QUALITY CONTROL

A. Material Sampling: Owner may at any time and any number of times during resinous flooring application require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.4 CLEANING AND PROTECTING

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 67 23

SECTION 09 84 33

SOUND-ABSORBING WALL PANELS

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. This section includes Metal Wall Panels as shown on the architectural drawings. Contractor shall provide a minimum 1200 SF of sound-absorbing wall panels with location as directed by Architect to coordinate with process piping.

B. Related Sections include the Following:

1. Section 09 84 36 – Sound-Absorbing Ceiling Panels.

1.3 SUBMITTALS

A. Manufacturer's Literature and Data:

1. Product Data: Submit manufacturer's technical data and brochures for specified system.

B. Shop Drawings:

1. Shop drawings shall show dimensions, sizes, thickness, finishes, joining, mounting attachments, and relationship to adjoining work.

C. Samples:

1. Samples shall include a minimum 12" X 12" nominal piece of each type of metal, finished as specified, and accessories.

D. Certification:

1. Submit certification from manufacturer of wall panels attesting that products comply with specified requirements including finish as specified.

E. Qualification Data:

1. Firms specified in "Quality Assurance" Article must demonstrate their capabilities and experience by including lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Product Test Reports:

1. All products furnished shall have a flame spread classification of 0-25 for a Class A or Class 1 rating in accordance with ASTM E84.
2. All products furnished shall be tested in accordance with ASTM C-423-90 for Sound Absorption. Test results for a Type A mounting method shall yield an NRC (Noise Reduction Coefficient) of no less than 1.0. Test results for a Type D-100 mounting method shall yield an NRC (Noise Reduction Coefficient) of no less than 1.15.

G. Maintenance Data:

1. Provide maintenance instructions for acoustical panels to be included in maintenance manuals as specified in Division 01.

H. Warranty:

1. Provide product warranty for one year from date of substantial project completion.

1.4 QUALITY ASSURANCE

A. Manufacturer: Firm with manufacturing and delivery capacity required for the project, shall have successfully completed at least ten projects within the past five years, utilizing systems, materials and techniques as herein specified.

B. Fabricator must own and operate its own Manufacturing facilities for all metal components. Systems consisting of components from a variety of manufacturers will not be considered or accepted.

C. Manufacturer/Fabricator must own and operate its own Painting and Finishing facility to assure single source responsibility and quality control.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct testing indicated, as documented according to ASTM E 548.

1.5 DELIVERY, STORAGE & HANDLING

A. All materials shall be protected during fabrication, shipment, site storage and erection to prevent damage to the finished work from other trades. Store acoustical panels inside a well-ventilated area, away from uncured concrete and masonry, and protected from the weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Manufacturer: ALPRO® Acoustical Systems manufactured by ALPRO® Acoustical Systems, Division of Gordon, Inc., 5023 Hazel Jones Road, Bossier

City, LA 71111, (888) 733-3836, FAX (800) 877-8746, www.alproacoustics.com, sales@alproacoustics.com.

B. Other systems may be submitted for approval; as provided for in the specifications at least 10 working days prior to submission of bids. Companies desiring to submit a proposal shall submit all descriptive information of the system proposed including photographs and shop drawings of at least three projects similar in detail and scope.

2.2 MATERIALS

A. Mounting Accessories

1. Extruded aluminum, brake form aluminum. Accessories shall include Z-furring, J Trim and inside/outside corner angles in a size and length to completely support and finish trim the wall panels as shown in elevations. All mounting accessories shall be finished to match wall panels.
2. Aluminum Extrusions shall be 6063-T6 alloy. (ASTM B 221, ASTM B 221 M)
3 General: Provide metals free from surface blemishes where exposed to view in finished unit. Surfaces that exhibit pitting, seam marks, roller marks, stains, and discolorations, or other imperfections on finished units are not acceptable. All metal shall be of the highest grade -commercial type,

B. Metal Panels

1. Aluminum sheet shall be 3003-H14 alloy, minimum 0.032 inch thick, (ASTM B 209).
2. The metal acoustical wall panels shall be corrugated and perforated with 1/8" diameter holes on 21/64" staggered centers, approximately 13% open area. Provide corrugation pattern as selected by Architect.
3. The panels shall be fabricated of smooth aluminum (0.032").

C. Sound Absorption Material:

1. Provide 2-inch thick fiberglass with 1.5 pcf density. The fiberglass panel shall be wrapped in Class A, per ASTM E84, black polyethylene.

2.3 FINISHES

A. Finish

1. Aluminum shall receive a factory applied and baked finish of a 70% Kynar® or Hylar 5000® (Fluropon® or Fluropon Classic® II) paint
2. All cut edges, including perforated holes must be coated. Finish shall be cured and oven baked to insure paint adhesion and uniform surface hardness.
3. Material that is to be field painted should be degreased and primed per paint manufacturer's specifications.

PART 3 –EXECUTION

3.1 INSPECTION

A. Examine building structure scheduled to receive wall panel system for unevenness or irregularities that would affect quality and execution of work.

B. Tolerances:

1. Install wall panel system with a maximum surface deviation of 1/8" in 4'-0" (No load applied) ASTM 635-92.

3.2 INSTALLATION

A. General: Comply with manufacturer's printed instructions, governing regulations for Seismic Codes, and with the Ceiling & Interior Systems Construction Association standards applicable to work.

B. Space Enclosure: Do not install any work until space is enclosed and weatherproofed, wet-work in space is completed and nominally dry, work above ceilings is complete, and temperature and humidity is continuously maintained at values near those of final occupancy.

3.3 CLEANING

A. Clean all surfaces following installation.

B. Replace material having scratches, abrasions, or other defects, with unblemished panels, or suspension.

C. Maintenance per manufacturer's finish maintenance instructions.

3.4 PROTECTION

A. Protection of acoustical panel systems from damage by other trades after installation to be provided by general contractor.

3.5 GENERAL RESPONSIBILITY

A. Variation from specification: Any variation from this specification resulting in additional cost to any other contractor or subcontractor on this project shall be the sole financial responsibility of the contractor for the work of this section.

END OF SECTION 09 84 33

SECTION 09 94 36

SOUND-ABSORBING CEILING PANELS

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. This section includes Metal Ceiling Panels as shown on the architectural drawings.

B. Related Sections include the Following:

1. Section 09 84 33 – Sound-Absorbing Wall Panels.

1.3 SUBMITTALS

A. Manufacturer's Literature and Data:

1. Product Data: Submit manufacturer's technical data and brochures for specified system.

B. Shop Drawings:

1. Shop drawings shall show dimensions, sizes, thickness, finishes, joining, mounting attachments, and relationship to adjoining work.

C. Samples:

1. Samples shall include a minimum 12" X 12" nominal piece of each type of metal, finished as specified, and accessories.

D. Certification:

1. Submit certification from manufacturer of ceiling panels attesting that products comply with specified requirements including finish as specified.

E. Qualification Data:

1. Firms specified in "Quality Assurance" Article must demonstrate their capabilities and experience by including lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Product Test Reports:

1. All products furnished shall have a flame spread classification of 0-25 for a Class A or Class 1 rating in accordance with ASTM E84.
2. All products furnished shall be tested in accordance with ASTM C-423-90 for Sound Absorption. Test results for a Type E-400 ceiling mounting method shall yield an NRC (Noise Reduction Coefficient) of no less than 1.0.

G. Maintenance Data:

1. Provide maintenance instructions for acoustical panels to be included in maintenance manuals as specified in Division 01.

H. Warranty:

1. Provide product warranty for one year from date of substantial project completion.

1.4 QUALITY ASSURANCE

A. Manufacturer: Firm with manufacturing and delivery capacity required for the project, shall have successfully completed at least ten projects within the past five years, utilizing systems, materials and techniques as herein specified.

B. Fabricator must own and operate its own Manufacturing facilities for all metal components. Systems consisting of components from a variety of manufacturers will not be considered or accepted.

C. Manufacturer/Fabricator must own and operate its own Painting and Finishing facility to assure single source responsibility and quality control.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct testing indicated, as documented according to ASTM E 548.

1.5 DELIVERY, STORAGE & HANDLING

A. All materials shall be protected during fabrication, shipment, site storage and erection to prevent damage to the finished work from other trades. Store acoustical panels inside a well-ventilated area, away from uncured concrete and masonry, and protected from the weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Manufacturer: ALPRO® Acoustical Systems manufactured by ALPRO® Acoustical Systems, Division of Gordon, Inc., 5023 Hazel Jones Road, Bossier City, LA 71111, (888) 733-3836, FAX (800) 877-8746, www.alproacoustics.com, sales@alproacoustics.com.

B. Other systems may be submitted for approval; as provided for in the specifications at least 10 working days prior to submission of bids. Companies desiring to submit a proposal shall submit all descriptive information of the system proposed including photographs and shop drawings of at least three projects similar in detail and scope.

2.2 MATERIALS

A. Suspension System

1. Extruded aluminum shall consist of main tees, cross tees, perimeter angle, perimeter trim, and any necessary clips and splices required for a complete system as required to meet local building codes.
2. Deflection of grid shall be limited to L/360 of the span when full dead load is applied. (ASTM C 635)
3. Aluminum Extrusions shall be 6063-T6 alloy. (ASTM B 221, ASTM B 221 M)
4 General: Provide metals free from surface blemishes where exposed to view in finished unit. Surfaces that exhibit pitting, seam marks, roller marks, stains, and discolorations, or other imperfections on finished units are not acceptable. All metal shall be of the highest grade -commercial type,

B. Metal Panels

1. Aluminum sheet shall be 3003-H14 alloy, minimum 0.032 inch thick, (ASTM B 209).
2. The metal acoustical ceiling panels shall be corrugated and perforated with 1/8" diameter holes on 21/64" staggered centers, approximately 13% open area. Provide corrugation pattern as selected by Architect.
3. The panels shall be fabricated of smooth aluminum (0.032").

C. Sound Absorption Material:

1. Provide 2-inch thick fiberglass with 1.5 pcf density. The fiberglass panel shall be wrapped in Class A, per ASTM E84, black polyethylene.

2.3 FINISHES

A. Finish

1. Aluminum shall receive a factory applied and baked finish of a 70% Kynar® or Hylar 5000® (Fluropon® or Fluropon Classic® II) paint
2. All cut edges, including perforated holes must be coated. Finish shall be cured and oven baked to insure paint adhesion and uniform surface hardness.
3. Material that is to be field painted should be degreased and primed per paint manufacturer's specifications.

PART 3 –EXECUTION

3.1 INSPECTION

A. Examine building structure scheduled to receive ceiling panel system for unevenness or irregularities that would affect quality and execution of work.

B. Tolerances:

1. Install ceiling system with maximum permissible deflection of L/360 of span maximum surface deviation of 1/8" in 4'-0" (No load applied) ASTM 635-92.

3.2 INSTALLATION

A. General: Comply with manufacturer's printed instructions, governing regulations for Seismic Codes, and with the Ceiling & Interior Systems Construction Association standards applicable to work.

B. Space Enclosure: Do not install any work until space is enclosed and weatherproofed, wet-work in space is completed and nominally dry, work above ceilings is complete, and temperature and humidity is continuously maintained at values near those of final occupancy.

3.3 CLEANING

A. Clean all surfaces following installation.

B. Replace material having scratches, abrasions, or other defects, with unblemished panels, or suspension.

C. Maintenance per manufacturer's finish maintenance instructions.

3.4 PROTECTION

A. Protection of acoustical panel systems from damage by other trades after installation to be provided by general contractor.

3.5 GENERAL RESPONSIBILITY

A. Variation from specification: Any variation from this specification resulting in additional cost to any other contractor or subcontractor on this project shall be the sole financial responsibility of the contractor for the work of this section.

END OF SECTION 09 84 36

SECTION 09 90 00

PAINTING AND PROTECTIVE COATINGS

PART 1 – GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
    a. C203, Coal–Tar Protective Coatings and Linings for Steel Water Pipelines–Enamel and Tape–Hot–Applied.
    b. C209, Cold–Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
    c. C213, Fusion–Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
    d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. The Society for Protective Coatings (SSPC):
    a. P A 2, Measurement of Dry Coating Thickness with Magnetic Gages.
    b. P A 3, Guide to Safety in Paint Applications.
    c. SP 1, Solvent Cleaning.
    d. SP 2, Hand Tool Cleaning.
    e. SP 3, Power Tool Cleaning.
    f. SP 5, White Metal Blast Cleaning.
    g. SP 6, Commercial Blast Cleaning.
    h. SP 7, Joint Surface Preparation Standard Brush–Off Blast Cleaning.
    i. SP 10, Near–White Blast Cleaning.
    j. SP 11, Power Tool Cleaning to Bare Metal.
    k. SP 12, Surface Preparation and Cleaning of Metals Water jetting Prior to Recoating.
    l. SP 13, Surface Preparation of Concrete.
    m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.
7. Master Painters Institute (MPI)

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PDS: Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Data Sheets:

a. For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
b. For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
c. Technical and performance information that demonstrates compliance with Specification.
d. Furnish copies of paint system submittals to the coating applicator.
e. Indiscriminate submittal of only manufacturer's literature is not acceptable.
f. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
g. Printout of current "MPI Approved Products List" with the proposed product highlighted for those products specified in paragraph “Architectural Paint Systems and Application Schedule” herein.

2. Detailed chemical and gradation analysis for each proposed abrasive material.
3. Paint Color Schedule: List of paint colors selected (manufacturer, name and number) and corresponding locations of application.
4. Samples:

a. Reference Panel:

1) Paint & Coatings:
(a) Unless otherwise specified, before painting work is started, prepare samples as required in “Mockup” herein.

(b) Furnish additional samples as required until colors, finishes, and textures are approved.
(c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Applicator's Qualification: List of references substantiating experience.
2. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 00 01, General Requirements.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer's written verification that submitted material is suitable for the intended use.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
6. Manufacturer's written instructions and special details for applying each type of paint and coating.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.

2. Perform surface preparation and painting in accordance with recommendations of the following:

a. Paint manufacturer's instructions.
b. SSPC P A 3, Guide to Safety in Paint Applications.
c. Federal, state, and local agencies having jurisdiction.

C. MPI Standards for Architectural Paint Systems:

1. Products listed in paragraph “Architectural Paint Systems and Application Schedule” shall comply with MPI Standards indicated and listed in current “MPI approved Products List”.
2. Preparation and workmanship of products listed in paragraph “Architectural Paint Systems and Application Schedule” shall comply with requirements in “MPI Architectural Painting Specification Manual”.

D. Mockup:

1. Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
2. Unless noted otherwise, prepare minimum 8–inch by 10–inch sample with type of paint and/or coating and application specified on similar substrate to which paint and/or coating is to be applied.

a. Wall Surfaces: Provide samples on at least 100 sq. ft. of wall surface.

b. Doors: Provide full size samples for interior and exterior doors.

3. If preliminary color selections are not approved, additional benchmark samples of additional colors selected by Architect shall be provided by the Contractor at no added cost to Owner.
4. Final approval of color selections will be based on benchmark samples which shall serve as the quality standard for final finishes.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

a. Product name or title of material.
b. Product description (generic classification or binder type).
c. Manufacturer's stock number and date of manufacture.
d. Contents by volume, for pigment and vehicle constituents.
e. Thinning instructions.
f. Application instructions.
g. Color name and number.

B. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

C. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being top coated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.

2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

C. Each of the following manufacturers is capable of supplying most of the paint products specified in paragraph "Architectural Paint Systems and Application Schedule" herein:

1. Sherwin Williams.
2. Tnemec.
3. PPG Architectural Finishes.
4. Benjamin Moore & Co.
5. Rose Talbert Paints

D. Acceptable manufacturers of other paints and/or coatings are as specified in Section 3.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single–component, finish as required.
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil.
Alkyd Wood Primer	Flat alkyd
Bituminous Paint	Single–component, coal–tar pitch based.

Product	Definition
Block Filler	Primer–sealer designed for rough masonry surfaces, 100% acrylic emulsion.
Coal–Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service.
DTM Acrylic Primer	Surface tolerant, direct–to–metal water borne acrylic primer.
DTM Acrylic Finish	Surface tolerant, direct–to–metal water borne acrylic finish coat.
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service.
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required.
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Primer–Ferrous Metal	Anticorrosive, converted epoxy primer containing rust–inhibitive pigments.
Epoxy Primer–Other	Epoxy primer, high–build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated.
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service.
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster–Carr Supply Corporation., Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA.
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat.
High Solids Polyurethane	Two–component, low VOC, aliphatic, acrylic polyurethane resin coating having a minimum of 65% volume solids; high gloss or semi gloss finish
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for top

Product	Definition
	coating.
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats.
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two–component, aliphatic or acrylic based polyurethane; high gloss finish
Rust–Inhibitive Primer	Single–package steel primers with anticorrosive pigment loading
Sanding Sealer	Co–polymer oil, clear, dull luster.
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based.
Stain, Concrete	Acrylic, water repellant, penetrating stain.
Stain, Wood	Satin luster, linseed oil, solid or transparent as required.
Varnish	Non–pigmented vehicle based on a variety of resins (alkyd, phenolic, urethane) in gloss, semigloss, or flat finishes, as required.
Water Base Epoxy	Two–component, polyamide epoxy emulsion, finish as required.

2.04 MIXING

A. Multiple–Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple–component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.

B. Surface Preparation: Provide Contractor minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie–coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie–coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

2.06 ARCHITECTURAL PRODUCTS

The following is to be applied to all paint systems except where specifically noted otherwise herein and on the Drawings.

A. Exterior Metal Primer: Primer, Epoxy, Anti-Corrosive, for Metal: MPI #101

B. Exterior Wood Primer: Primer, Alkyd for Exterior Wood: MPI #5.

C. Exterior Water-Based Paint: Light Industrial Coating, Exterior, Water Based, Gloss (Gloss Level 6): MPI #164.

D. Exterior Latex Paint: Exterior Latex (Semigloss) MPI #11 (Gloss Level 5).

E. Interior Primers / Sealers: Interior Latex Primer/Sealer MPI #50.

F. Interior Metal Primers:

a. Quick-Drying Alkyd Metal Primer MPI #76.
b. Waterborne Galvanized-Metal Primer: MPI #134.

G. Interior Latex Paints:

a. Interior Latex (Eggshell) MPI #52 (Gloss Level 3).
b. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).

H. Epoxy Coatings: Epoxy-Modified Latex, Interior, Gloss (Gloss Level 6) MPI #115.

PART 3 – EXECUTION

3.01 GENERAL

A. Provide Contractor minimum 7 days' advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Inspector, unless Engineer grants prior approval to perform the Work in Inspector’s absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Contractor.

3.02 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Contractor before repairing damaged factory-finished items delivered to Site.
2. Repair abraded or otherwise damaged areas on factory–finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

C. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent
2. Masonry: 12 percent
3. Wood: 15 percent
4. Gypsum Board: 12 percent

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry. Commencement of coating application constitutes Contractor's acceptance of substrates and conditions.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated in paragraph “Architectural Paint Systems and Application Schedule”.

B. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:

a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.

b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power–assisted hand tools.
d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
f. SP 7, Brush–Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
g. SP 10, Near–White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power–assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
i. SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high–pressure and ultrahigh–pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ–l through WJ–4 for visual surface preparation definitions and SC–l through SC–3 for nonvisual surface preparation definitions.

2. The words "solvent cleaning," "hand tool cleaning," "wire brushing," and "blast cleaning," or similar words of equal intent in these Specifications or in paint manufacturer's specification refer to the applicable SSPC Specification.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu–blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.

7. Welds and Adjacent Areas:

   a. Prepare such that there is:

      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or any area to be painted.
      3) No sharp peaks or ridges along weld bead.

   b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

8. Preblast Cleaning Requirements:

   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.

9. Blast Cleaning Requirements:

   a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
   b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
   c. Use only dry blast cleaning methods.
   d. Do not reuse abrasive, except for designed recyclable systems.
   e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.

10. Post–Blast Cleaning and Other Cleaning Requirements:

   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
   b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

C. Galvanized Metal Surface Preparation:

1. Prepare in accordance with ASTM D 6386 and recommended procedures from the American Galvanizers Association (AGA).

2. Notify galvanizer that steel will be painted.
3. Newly Galvanized Metal (48 hours or less since galvanizing):

    a. Grinding: removed excess zinc, remove dross particles, bumps, runs and drips by hand grinder. If process removes too much zinc, surface must be repaired in accordance with ASTM A780.
    b. Ensure surface is free of oil, grease, dirt and other organic materials. If it is not, see Partially Weathered for cleaning procedure.
    c. Rinse thoroughly and dry.
    d. Profile by sweep blasting at a maximum pressure of 40 psi, wash primer or acrylic pre-treatment. Take care not to damage the galvanized coating.

4. Partially Weathered Metal (2 days – 12 months from galvanizing):

    a. Grinding as previously defined for Newly Galvanized Metal.
    b. Clean surface of organic compounds and wet storage stain using alkaline solution or solvent cleaning.
    c. Rinse thoroughly and dry.
    d. Profile as previously defined for Newly Galvanized Metal.

5. The pressure of cleaning or rinsing performed must not exceed 1450 psi.
6. Apply paint or coating within 12 hours of drying.

D. Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Remove oil and grease by wiping or scrubbing surface with suitable solvent, rag, and brush. Use clean solvent and clean rag for final wiping to avoid contaminating surface.
3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

E. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Adhere to manufacturer’s recommendations for preparation of the concrete surface. Ensure surface is free from grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter.
4. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after preparation.
5. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

F. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.

2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:

    a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
    b. Brush–off blasting.
    c. Water blasting.

4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

G. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Contractor prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:

    a. Synthetic–based wood putty approved by paint manufacturer for paint system.
    b. For natural finishes, color of wood putty shall match color of finished wood.
    c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
    d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.
    e. Use cellulose type putty for stained wood surfaces.
    f. Ensure surfaces are clean and dry prior to painting.

H. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.

1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

3.05 SURFACE CLEANING

A. Brush–off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for new, interior and exterior masonry, concrete, and metal, surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Apply coatings and paint in accordance with these Specifications and manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
4. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
5. Water–Resistant Gypsum Board: Use only solvent type paints and coatings.
6. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
7. Keep paint materials sealed when not in use.
8. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, Such As Concrete and Masonry:

1. Repairs shall be completed using products specified in Section 03 30 00 Cast-In-Place Concrete.
2. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects that may inhibit or prevent adequate application of coating.
3. Prime Coat: If it acceptable to the manufacturer, prime coat may be thinned to provide maximum penetration and adhesion. The reduction volume shall be determined by the manufacturer specific to the density and type of coating being applied. Reduction shall not be implemented if it voids the warranty of any product.
4. Surface Specified to Receive Water Base Coating: For most applications, surface shall be damp just prior to application of coating, but free of running water. Verify this requirement with manufacturer for specified product.

D. Film Thickness and Coverage:

1. Number of Coats:

   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.

2. Application Thickness:

   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.

3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:

   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with Specification.
   c. Coats are subject to inspection by Contractor and coating manufacturer's representative.

4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 FIRE RATED ASSEMBLIES

A. Permanently identify corridor partitions, smoke stop partitions, horizontal exit partitions, exit enclosures and fire walls. Above decorative ceiling line and in concealed spaces, apply a minimum one-inch wide red line interrupted at maximum 15-ft spacing with the wording "X HOUR FIRE AND SMOKE BARRIER - PROTECT ALL OPENINGS" in 4-inch high letters with "X" designating the appropriate hourly rating.

3.08 FIELD QUALITY CONTROL

A. Owner reserves the right to invoke test procedure at any time and as often as Owner deems necessary during the period when paint is being applied.

1. Owner may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove noncomplying paint from Project site, pay for testing, and repaint surfaces previously coated with the noncomplying paint.

B. Testing: Testing is to be performed on the waterproof and anti-corrosion coatings applied to the interior surfaces of the Basins.

1. Thickness and Continuity Testing:

a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC P A 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.
c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.
d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

2. Testing Equipment:

a. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
b. Provide low–voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high–build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M–I.
c. Provide high–voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Apply finish coats, including touchup and damage–repair coats in a manner that will present a uniform texture and color–matched appearance.

3.08 MANUFACTURER'S SERVICES

A. Coating manufacturer's representative shall be present at Site for the application of the waterproof and anti-corrosion coatings for the Basins as follows:

1. On first day of application of any coating system.
2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
3. During thickness and continuity testing to verify conformance with project and manufacturer requirements.
4. As required to resolve field problems attributable to or associated with manufacturer's product.
5. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.09 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.10 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces–in accordance with the following application schedule and the environmental types defined in Section 01 00 01, General Requirements. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. System No. 2 Submerged Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	
	Coal–Tar Epoxy –OR– High Build Epoxy	2 coats, 16 MDFT 2 coats, 16 MDFT

1. Use on the following items or areas:

   a. New metal surfaces located in submerged environment type.
   b. New metal surfaces above maximum liquid surface that are a part of submerged equipment.
   c. Submerged surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gates, gate guides, thimbles, and structural steel that are embedded in concrete.
   d. Interior surfaces of steel piping noted in the Piping Schedule.

C. System No. 4 Galvanized Metal, Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
See Preparation section of this specification	Zinc-Rich Primer	1 coat, per mfr
	Top Coat – Acrylic Latex	1 coat, per mfr

1. Use on the following items or areas:

   a. Exposed new metal surfaces located in interior equipment/blower room
   b. Exposed metal deck.
   c. Structural steel, including beams and columns of monorail and porch framing.
   d. Exposed stair and platform framing.
   e. Steel lintels.
   f. Exterior doors and frames.

D. System No. 5 Exposed Metal, Mildly Corrosive:

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

1. Use on the following items or areas:

   a. Miscellaneous exposed new metal surfaces inside the 2nd level of the building.
   b. Interior doors and frames.

E. System No. 6 Exposed Metal Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust Inhibitive Primer	1 coat, 2 MDFT
	Alkalyd Enamel	2 coats, 4 MDFT

1. Use on the following items or areas:

a. Exposed new metal surfaces including vents, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim.
b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.
c. Interior doors and frames unless specified otherwise.

F. System No. 8 Buried Metal General:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near White Blast Cleaning	Coal–Tar Epoxy	2 coats, 125 microns each
	Coal-Tar Primer, Coal-Tar Enamel	1 coat, per mfr 2 coats, hot applied per mfr

1. Use on the following items or areas:

a. Buried, below grade portions of steel items, except buried stainless steel or ductile iron and the following specific surfaces:

1) Fasteners and accessories of buried piping related items.

2) Steel H piles, the coating for which is defined in Section 31 62 13.23

G. System No. 10 Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Nonferrous Metal Alloy Surface Preparation	Epoxy Primer–Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:

a. Aluminum handrail, grating, panels, and miscellaneous components both interior and exterior.

b. After application of System No. 10, apply finish coats as required for exposure. For handrail apply per specifications herein. For other items apply per manufacturer recommendations.

H. System No. 11 Galvanized Metal Repair:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SPI) Followed by Hand Tool (SP 2), Power Tool (SP 3) or Brush off Blast (SP 7)	Organic Zinc Rich Primer	1 coat, 3 MDFT

1. Use on the following items or areas:
    a. Galvanized surfaces that are abraded, chipped or otherwise damaged.

I. System No. 19 Concrete Tank Waterproof Coating:

Surface Prep.	Paint Material	Min. Coats, Wet Thickness
As specified by the manufacturer	CIM 61BG Epoxy Primer	1 coat, 10 mil (wet)
	CIM 1000	2 coats, 60* mil (wet)

*Apply extra thickness at corners, intersections, angles and over joints.

1. Use on the following items or areas:
    a. Base slab of all basins.
    b. Lower 19 feet of Anoxic, Pre-Aeration and Membrane Thickening Basins.
    c. Entire wall height of MBR and RAS Basins.

J. System No. 20 Concrete Tank Anti-Corrosion Coating:

Surface Prep.	Paint Material	Min. Coats, Dry Thickness
As specified by the Manufacturer	Primer: Chesterton ARC 797 Finish: Chesterton ARC S1HB	1 coat, 7-10 mil (dry) 2 coats min, 100 mil (dry)
	OR Raven 404 System	3 coats min, 60 mil

1. Use on the following items or areas:
    a. Top 5 feet of the walls of Anoxic, Pre-Aeration and Membrane Thickening Basins.
    b. Underside of all concrete slabs and walkways over all Basins.

K. System No. 21 Decorative Abrasion Resistant Concrete Finish:

Surface Prep.	Paint Material	Min. Coats, Cover
Shot blast concrete as specified by manufacturer	Stontec UTF, by Stonhard Inc.	As specified by manufacturer

1. Use on the following items or areas:
    a. Floor of the Control Room, Bathroom and Shower Room (all three on 2nd floor of the building).

L. System No. 22 Decorative Abrasion Resistant Non-Slip Concrete Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
Shot blast concrete as specified by manufacturer	Stontec UTF with White Texture, by Stonhard Inc.	As specified by manufacturer

2. Use on the following items or areas:
    a. Exterior concrete slab on 2nd level at top of stairs and at covered area between monorail bay and building CMU wall.

M. System No. 23 Chemical–Resistant Floor and Wall Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
Shot blast concrete as specified by manufacturer	Stonchem 830, by Stonhard Inc.	As specified by manufacturer

3. Use on the following items or areas:
    a. Interior slab on grade and equipment slabs of the Equipment Room.
    b. Lower 6 inches of all walls in the Equipment Room.

N. System No. 25 Exposed PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:

   a. All exterior, exposed–to–view PVC and CPVC surfaces.

O. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete.

P. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near–White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT

1. For steel pipe and fittings, meet all requirements of AWWA C2l3.
2. Use on the following items:

   a. Interior and exterior of valves as specified in Section 40 27 02 Process Valves and Operators.

3.11 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. System No. 102 Wood, Exterior:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Wood Surface Preparation	Alkyd Wood Primer, MPI #5	1 coat
	Latex, exterior, matching topcoat	1 coat
	Latex, exterior gloss (Gloss Level 6), MPI #119	1 coat

1. Use on the following items or areas:

   a. All exterior wood.

C. System No. 1 06 Wood, Interior, Latex System: N/A

D. System No. 109 Masonry, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Masonry Surface Preparation	Block Filler	1 coat, 75 SFPG
	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Interior CMU wall in Equipment Room of building.

E. System No. 112 Concrete, Flat:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Acrylic Latex (Flat)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Basin exterior walls.
   b. Lower wall of building as indicated on Drawing Elevations.

F. System No. 114 Gypsum Board, Latex System:

Surface Prep.	Paint Material	Min. Coats
In accordance with Paragraph Gypsum Board Surface preparation	Interior Latex Primer Sealer	1 coat
	Interior latex matching topcoat	1 coat
	Interior latex (eggshell)	1 coat

1. Use Latex System MPI INT 9.2A on the following items or areas:
   a. Interior gypsum board in dry areas.

G. System No. 115 Gypsum Board, Epoxy-Modified Latex System:

Surface Prep.	Paint Material	Min. Coats
In accordance with Paragraph Gypsum Board Surface preparation	Skim coat of joint compound	1 coat
	Primer sealer, latex, interior	1 coat
	Epoxy-modified latex, interior, gloss (Gloss Level 6)	2 coats

1. Use Epoxy-Modified Latex System MPI INT 9.2F on the following items or areas:
   a. Interior gypsum board in wet areas.

3.12 COLORS

A. Provide as designated by the Architect in Finish Schedule.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
2. Paint equipment and piping one color as selected.
3. Paint non – submerged portions of equipment the same color as the piping it serves, except as itemized below:
   a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
   b. Fire Protection Equipment and Apparatus: OSHA Red.
   c. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

1. Color code non – submerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Pipe Color Coding: In accordance with Piping Schedule and/or selected by the Engineer.
3. Pipe Supports (for metals that are not galvanized steel, aluminum and stainless steel): Painted light gray, as approved by Engineer.
4. PVC and CPVC pipe located inside of buildings and enclosed structures will not require painting except as noted or scheduled.

3.13 SUPPLEMENTS

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

1. Paint System Data Sheet (PSDS).
2. Product Data Sheet (PDS).

END OF SECTION

PAINT PRODUCT DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio:_____

Maximum Permissible Thinning: _____

Ambient Temperature Limitations: min.:_____ max: _____

Surface Temperature Limitations: min.:_____ max: _____

Surface Profile Requirements: min.:_____ max: _____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

PAINT SYSTEM DATA SHEET

Complete this PDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PDS.

Paint System Number (from Spec):		
Paint System Title (from Spec):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

SECTION 10 14 00

IDENTIFYING DEVICES

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American National Standards Institute (ANSD:

   a. A13.1, Schemes for the Identification of Piping Systems.
   b. A117.1, Buildings and Facilities–Accessibility and Usability for Physically Handicapped People.
   c. D6.1, Manual on Uniform Traffic Control Devices for Streets and Highways.

2. American Society for Testing and Materials (ASTM): A53, Standard Specification for Pipe, Steel, Black and Hot–Dipped, Zinc–Coated Welded and Seamless.

3. The Chlorine Institute, Inc.: WC–1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.

4. Federal Specifications (FS): L–P–387 A(1), Plastic Sheet, Laminated, Thermosetting (for Designation Plates).

5. International Conference of Building Officials (ICBO): Uniform Fire Code (UFC).

6. National Fire Protection Association (NFPA):

   a. 49, Hazardous Chemicals Data.
   b. 704, Standard System for the Identification of the Fire Hazards of Materials.

7. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

A. Shop Drawings:

1. Drawings showing layouts, actual letter sizes and styles, and project–specific mounting details for every sign type.

2. Manufacturer's literature showing letter sizes and styles, sign materials, and standard mounting details.

B. Samples: One full size for each type of nameplate, sign, and label specified.

C. Quality Control Submittals: Manufacturer's installation instructions.

PART 2 – PRODUCTS

2.01 DOOR NAMEPLATES (TYPE A)

A. Material: Three–ply laminated fiberglass, minimum 1/8–inch thick, with contrasting color core message layer between two clear weather–resistant surface layers.

B. Manufacturers:

1. Brady Signmark
2. Seton Name Plate Corp.
3. Approved Equal

C. Finish: Non –directional matte.

D. Size: See Sign Schedule (attached)

E. Letters:

1. Size: l–inch high unless noted otherwise in schedule.
2. Color: See Sign Schedule (attached).
3. Style: See Sign Schedule (attached).
4. Message Text: See Sign Schedule (attached).

2.02 PICTORIAL SYMBOLS (TYPE G)

A. Material: Three–ply laminated fiberglass, minimum 1/8–inch thick, with contrasting color core message layer between two clear weather–resistant surface layers. Use international handicapped unisex toilet symbol.

B. Manufacturers:

1. Brady Signmark
2. Seton Name Plate Corp.
3. Approved Equal

C. Size: See Sign Schedule (attached).

D. Manufacture: ANSI A1l7.l, Section 4.30.

2.03 METAL SIGNS (TYPE B):

A. Material: Baked enamel finished 20–gauge (minimum) steel or 18–gauge (minimum) aluminum signs.

B. Manufacturers:

1. Seton Name Plate Corp.
2. Nutheme Illustrated Safety Co.
3. Approved Equal

2.04 HAZARDOUS MATERIAL SIGNS (TYPE H):

A. Conform to NFPA 704, 49 and NFPA HAZ–01.

B. Material: Fiberglass 1/8 inch thick or Reflective sheeting applied to 0.040–inch thick aluminum.

C. Background, Letters, and Numbers: Die–cut vinyl with pressure sensitive adhesive.

D. Manufacturers:

1. Brady Signmark.
2. Seton Name Plate Corp.
3. Approved Equal

2.05 CUSTOM SIGN (TYPE Q):

A. Provide a facility plaque made by Impact Signs of LaGrange, IL or approved equal.

B. Size: 16” high x 18” long

C. Material: Cast Bronze

D. Finish: Light Oxidized

E. Background Texture: Stipple, Black

F. Border: Single

G. Attachment: Rosette #4

H. Text: Copperplate, Capital Letters

I. Message: See attached mock-up of plaque

2.06 IDENTIFICATION LABELS

A. PVC Pipe Labels and Flow Direction Arrows:

1. Lettering and Arrows: Black print.

2. Background: OSHA safety yellow.

3. Material: Manufacture from or encase in outdoor grade plastic or vinyl that will resist damage or fading from wash-down, sunlight, mildly corrosive atmosphere, dirt, grease, and abrasion.

4. Label, Lettering Size, and Color: ANSI A13.I.

5. Message: See Piping Schedule.

6. Labels:

   a. Snap–Around Type: Size for finished outside diameter of pipe and insulation.
   b. For 6 Inches and Over Diameter Pipe: May furnish strap–on type fastened without use of tools with plastic or stainless steel straps.
   c. Firmly grip pipe so labels remain fixed in vertical pipe runs.

7. Manufacturers and Products:

   a. T & B/Westline, Rariton, NJ; Model WSS Snap–Around.
   b. Seton Name Plate Corp., New Haven, CT; Setmark Series.

8. Note: All other pipes shall have painted labels; see Section 09 90 00, Painting and Protective Coating.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers wherever specified on Drawings.

2. Lettering: Black bold face, 3/4–inch minimum high.

3. Background: OSHA safety yellow.

4. Materials: Either of the following:

   a. Aluminum or stainless steel base with a baked–on finish that is suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
   b. Fiberglass with fiberglass–encased lettering.

5. Furnish I–inch margin on each end of label for mounting. On fiberglass labels furnish grommets at each end for mounting.

5. Size:

   a. Two inches minimum and 3 inches maximum high by 14 inches minimum and 18 inches maximum long.
   b. Furnish same size base dimensions for all labels.

7. Message: Equipment names and tag numbers as used in sections where equipment is specified.

8. Manufacturers and Products:

   a. T & B/Westline Co., Rariton, NJ; Type KQ.
   b. Seton Name Plate Corp., New Haven, CT; Style EB.

c. W. H. Brady Co., Milwaukee, WI; Fiber–Shield.

2.04 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

B. Pipe Posts: 2–1/2–inch galvanized steel pipe meeting ASTM A53, Type S, Grade B.

C. Chain: Type 304 stainless steel, No. 16 single jack chain or No.2 double loop coil chain.

PART 3 – EXECUTION

3.01 INSTALLATION –GENERAL

A. In accordance with manufacturer's recommendations.

B. Mount securely, plumb, and level.

3.02 DOOR NAMEPLATES AND PICTORIAL SYMBOLS

A. Attach to doors or walls adjacent to doors with self–sticking permanent removable adhesive. See Door Schedule for locations and messages.

B. Mount with bottom of nameplate at 5 feet 6 inches above floor.

3.03 SIGNS

A. Fasten to walls or posts or hang as scheduled. Anchor in place for easy removal and reinstallation with ordinary hand tools.

B. Information, Exit, and Safety Signs:

1. Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.

2. Removable with ordinary hand tools without leaving scars on structure or equipment.

C. Hazardous Material Signs:

1. Install where required by NFPA No. 704 and UFC, Chapter 79.

2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled and on sides of stationary tanks.

3. Specific Materials:

Hazardous Materials					
Mark	**Material**	**Health Hazard (Blue)**	**Flammability Hazard (Red)**	**Instability Hazard (Yellow)**	**Special Hazard (White)**
See Schedule	Emulsion Polymer	1	1	0	
See Schedule	Citric Acid	2	1	0	
See Schedule	Ferric Chloride (35 – 40% solution)	3	0	0	
See Schedule	Sodium Hydroxide (10 – 30% solution)	2	0	0	
See Schedule	Sodium Hypochlorite (12 – 15% solution)	2	0	0	
See Schedule	No 2 Diesel Fuel	0	2	0	
See Schedule	Potable Water	0	0	0	4
See Schedule	Non Potable Water (effluent)	7	0	0	0

3.04 IDENTIFICATION LABELS

A. PVC Pipe Labels and Flow Indication Arrows:

1. Locate at all connections to equipment, valves, or branching fittings at wall boundaries.

2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.

3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.

4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.

5. Application: To pipe only after painting in vicinity is complete or as approved by Engineer.

6. Installation: In accordance with manufacturer's instructions.

B. Equipment Labels:

1. Locate and Install: On equipment or concrete equipment base.

2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

3.05 SIGN SCHEDULE

A. Sign Schedule following "END OF SECTION" is a tabulation of sign characteristics and mounting information for each sign shown by its "Mark" on Drawings, and is a part of this Specification.

B. Provide signs as scheduled.

C. Meet requirements of Federal Occupational Health Act (OSHA).

1. Close valve on truck hose.

3.06 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are part of this Specification.

1. 3 Sign Schedules.

2. 1 Mock-Up Plaque.

END OF SECTION

SIGN							MOUNTING			LETTERING					OTHER REQUIREMENTS
Location	Qty	Type	Format	Maximum Size		Color	Location	Method	Height to Centerline	Height	Style	Color	Message	Faces	
				Width	Height										
Upper Level Bldg	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Control Room	1	Install on Door
Upper Level Bldg	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Mechanical Room	1	Install on Door
Upper Level Bldg	1	G	As specified	6”	6”	Gray	Door	Tape	5’ 0”	Symbol	Helvetica	Black	Unisex	1	Install on Door
Upper Level Bldg	2	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Electrical / MCC Room	1	Install on 2 Doors
Lower Level Bldg	1	A	As specified	12”	6”	Red/White	Wall	Bolts	5’ 6”	1”	Helvetica	Black	Danger High Voltage	1	As directed by Engineer
Lower Level Bldg	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Support Room	1	Install on West Personnel Door (Ext)
Lower Level Bldg	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Chemical Room	1	Install on West Personnel Door (Ext)
Lower Level Bldg	2	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Equipment Room	1	Install on 2 Personnel Doors (Int & Ext South)
Lower Level Bldg	1	H	Standard Hazmat	14”	10”	Red/White	Wall	Tape	5’6”	n/a	n/a	Black	Danger Sodium Hypochlorite	1	Install on Ext. of Chemical Room Door
Lower Level Bldg	1	H	Standard Hazmat	6”	6”	Standard Hazmat	Door	Tape	Below Window	n/a	n/a	Standard Hazmat	Corrosion Hazmat Symbol	1	As directed by Engineer
Various	10	B	Standard	20”	14”	Red/White	Chain	Hanging	Various	1”	Helvetica	Black	Non-potable Not for Drinking	1	As directed by Engineer
Lower Level Bldg	1	H	Standard Hazmat	14”	10”	Red/White	Wall	Tape	5’ 6”	n/a	n/a	Black	Danger Sodium Hydroxide	1	As directed by Engineer
Lower Level Bldg	1	Q	See Spec	18”	16”	Cast Bronze, see Spec	Wall	Rosette Screw	5’-6”		See Spec	Light Oxidized	See Spec	1	See Spec for details
Various	3	B	Standard	12”	6”	Blue/White	Wall		Various	1”	Helvetica	Black	Potable Water	1	As directed by Engineer

SIGN							MOUNTING			LETTERING					OTHER REQUIRE-MENTS
Location	Qty	Type	Format	Maximum Size		Color	Location	Method	Height to Centerline	Height	Style	Color	Message	Faces	
				Width	Height										
Centrifuge Building Exterior	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Centrifuge Building	1	Install on Personnel Door
Centrifuge Building Interior Wall at Polymer Storage	1	H	Standard Hazmat	6”	6”	Standard Hazmat	Door	Tape	Below Window	n/a	n/a	Standard Hazmat	Corrosion Hazmat Symbol	1	As directed by Engineer
Centrifuge Building Interior Wall at Polymer Storage	2	H	Standard Hazmat	14”	10”	Red/White	Wall	Tape	5’ 6”	n/a	n/a	Black	Danger Polymer Storage	1	As directed by Engineer
Various	2	B	Standard	12”	6”	Blue/White	Wall	Hang	Various	1”	Helvetica	Black	Potable Water	1	As directed by Engineer
Centrifuge Bldg Interior	1	n/a	Standard	10”	7”	Red/Black White	on wall to right of man door	Bolt	5’-6”	Std	Standard	White / Black	DANGER FLAMMABLE	1	Standard Plastic Danger Sign
Centrifuge Bldg Interior	1	n/a	Standard	10”	7”	Yellow / Black	on wall to right of man door	Bolt	5’-6”	Std	Standard	Yellow / Black	CAUTION HIGH NOISE LEVEL AREA	1	Ear Protection Fiberglass Sign

SIGN							MOUNTING			LETTERING					OTHER REQUIREMENTS
Location	Qty	Type	Format	Maximum Size		Color	Location	Method	Height to Centerline	Height	Style	Color	Message	Faces	
				Width	Height										
Plant Entrance Gates	2	A	As Specified	44”	24”	White	On chain link fence gate, as directed	Plastic ties on 4 corners	5’-6”	2”	Helvetica	Black	KIAWAH RIVER PLANTATION WASTEWATER TREATMENT FACILITY IN CASE OF EMERGENCY CALL 843-XXX-XXXX	1	Provide hole in each corner for attachment. Phone number to be provided upon ordering.
Holding Pond Entrance Gate	1	A	As Specified	44”	24”	White	On chain link fence gate, as directed	Plastic ties on 4 corners	5’-6”	2”	Helvetica	Black	KIAWAH RIVER PLANTATION WASTEWATER TREATMENT HOLD POND IN CASE OF EMERGENCY CALL 843-XXX-XXXX	1	Provide hole in each corner for attachment. Phone number to be provided upon ordering.

KIAWAH RIVER PLANTATION

WASTEWATER TREATMENT FACILITY

0.10 MGD MEMBRANE BIOREACTOR
(date of commissioning)

CONSULTING ENGINEER
Thomas & Hutton Engineering Co.
GENERAL CONTRACTOR
(to be determined)

SECTION 10 71 14

EXTERIOR SHUTTERS

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. This Section includes exterior shutters.

1.3 SUBMITTALS

A. Product Data for each type of shutter system required, including construction details, dimensions of components, profiles, and finishes.

1. Include schedule identifying each opening by number.

B. Shop Drawings for each type of shutter system required showing fully dimensioned plans, elevations, sections, and details. Show anchors and inserts for items attached to permanent construction. Include information not fully detailed in Product Data.

1. Include Setting Drawings, templates, and installation instructions for anchorages.

C. Samples for verification of the following:

1. Shutter material, 8 by 10 inches.
2. Fastener system components, one of each component.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed installation of shutter system similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Single-Source Responsibility: Provide each type of shutter system as a complete unit produced by a single manufacturer, including necessary mounting accessories, fittings, and fastenings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver shutter systems until construction is ready for their installation. Protect units from damage during delivery, storage, handling, and installation.

1.6 PROJECT CONDITIONS

A. Field Measurements: Where components are indicated to be fitted to other construction, verify dimensions of other construction by field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 EXTERIOR SHUTTERS

A. Manufacturers: Subject to compliance with requirements, provide shutters as manufactured by one of the following:

1. Custom Shutter Co.
2. MetalTech.
3. Willard Shutter Company.

B. Material: Extruded aluminum.

C. Hardware: Manufacturer's standard hinges and tilt arm components.

D. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

E. Style: Open louver, Bahama style shutter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install shutter system components level, plumb, and at indicated alignment with adjacent work.

B. Protect metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

END OF SECTION 10 71 14

SECTION 10 80 00

MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Toilet and Bath Accessories.
2. Lockers.
3. Benches.
4. Portable Fire Extinguishers.

1.02 REFERENCES

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

1. Factory Mutual (FM).
2. National Fire Protection Association (NFPA): No. 10, Standard for Portable Fire Extinguishers.
3. Occupational Safety and Health Act (OSHA).
4. Underwriters Laboratories Inc. (UL): Fire Protection Equipment List.
5. ASTM International:

    a. A591, Standard Specification for Steel Sheet, Electrolytic Zinc–Coated, for Light Coating Weight [Mass] Applications.
    b. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:

    a. Manufacturer's literature for toilet and bath accessories clearly indicating:

        1) Engineer's identification mark, size, and description of Components.
        2) Base material with surface finish inside and out.
        3) Hardware and locks and attachment devices.
        4) Description of rough–in framing.
        5) Details of blocking and anchorage required.

B. Informational Submittals:

1. Manufacturers' descriptions, installation data, color charts and cleaning and service instructions for all items proposed for use. Clearly identify each item.

2. Distributor's List: List of local distributors for all supplies required for the accessories installed.

PART 2 - PRODUCTS

2.01 TOILET AND BATH ACCESSORIES

A. Manufacturers:

1. Materials and products specified in this section shall be products of Bradley Corp.
2. Other Manufacturers:

   a. Bobrick Washroom Equipment, Inc.
   b. Accessory Specialties, Inc.

B. Finishes:

1. Stainless steel.
2. Manufacturer's or brand name on face of units is not acceptable.

C. Furnish accessory items listed where indicated by mark or note on Drawings.

Item	Mark	Bradley
Surf Mounted Double Roll Toilet Paper Dispense	TPD	No. 5123
Horizontal Wall Mounted Liquid Soap Dispenser	SD – 11	NO. 6542
Mirror, Size on Dwgs	MIR	No. 782
Surf. Mounted Paper Towel Dispenser	PTD – 1	No. 950 – 15
Waste Receptacle	WR – 1	No. 377 – 38
Surf. Mounted Napkin Disposal	ND	No. 4781 – 15
Mop and Broom Holder (44”)	M&BH	No. 9954
Robe Hook	RH	No. 912
Grab Bars 42”	GB – 1	No. 812 – 001
Grab Bars 36”	GB – 2	No. 812 – 001
Towel Bar	TB	No. 907
Shower Curtain w/Hooks 60”	SC – 2	No. 9537

D. See Plumbing Specifications for prefabricated shower enclosure with built-in grab bars, soap dish, folding seat and curtain rod.

E. Anchors: Furnish anchors, fasteners, or other devices necessary for a complete, secure installation.

F. Fasteners: Tamper–proof screws or bolts.

G. Supplies: Furnish fill supplies, such as paper goods, soap, and napkins, as recommended by accessory manufacturer.

2.02 LOCKERS

A. Solid plastic lockers to be manufactured by Scranton Products (Santana/Comtec/Capitol), 801 Corey Street, Moosic, PA 18507 or approved equal. These specifications will be regarded as minimum.

B. Locker doors and door frames shall be made from high impact, high density polyethylene (HDPE) formed under high pressure into solid plastic components 1/2 inch thick with homogeneous color throughout.

C. Sides, tops, bottoms, backs, and shelves shall be made from high impact, high density, polyethylene (HDPE) formed under pressure into solid plastic components 3/8 inch thick with homogenous natural color throughout. Components shall have machined edges to accept assembly brackets. Outside, insides, tops, bottoms, backs, dividers and shelves shall be natural in color.

D. Material Testing: All solid plastic components shall resist deterioration and discoloration when subjected to any of the following:

Acetic Acid 80%	Acetone
Ammonia Liquid	Ammonium Phosphate
Bleach 12%	Borax
Brine	Caustic Soda
Chlorine Water	Citric Acid
Copper Chloride	Core Oils
Hydrochloric Acid 40%	Hydrogen Peroxide 30%
Isopropyl Alcohol	Lactic Acid 25%
Lime Sulfur	Nicotine
Potassium Bromide	Soaps
Sodium Bicarbonate	Trisodium Phosphate
Urea and Urine	Vinegar
Testing in accordance with corrosion testing procedure established by the Unite State Plastic Corporation.	

E. Continuous latch shall be made from high impact HDPE plastic and capable of accepting various locking mechanisms. Latch shall be securely fastened to the entire length of the door, providing a continuous latch.

F. Door hinge shall be made from heavy duty extruded aluminum with a powder coating to match the locker door and frame. Door hinge shall be full length assembled onto the door and front.

G. Assembly profile shall be full depth, width and height of the lockers. Profile shall be made from PVC plastic and snap fit assembled onto locker outsides, insides, backs, tops and bottoms. The snap–fit design offers a continuous connection between components.

H. Coat hooks shall be two–prong and made from high impact plastic. Hooks shall be mounted to the bottom of the shelf or divider –one each per door opening (Standard on Single, Double & Triple tier lockers only).

I. All HDPE components shall have a smooth "orange peel" finish. Locker doors and door frames shall be of the same color and selected from the standard full color line.

J. Locker components shall be fabricated square and rigid with a finish free of scratches and chips.

K. Solid plastic locker components shall snap together for easy assembly and shall provide a solid and secure construction. Adjacent lockers shall share a common side panel. Locker units shall be manufactured for assembly in a group of no more than five adjacent lockers.

L. Lockers will have a warranty for a period of 15 years. The HOPE plastic doors, panels, dividers, and shelves shall be warranted against corrosion, rust, delamination and breakage under normal use.

2.03 PLASTIC HDPE BENCHES

A. Locker room benches and pedestals to be supplied by Scranton Products (Santana/Comtec/Capitol), Moosic, P A, or approved equal.

B. Locker room bench tops shall be *1–1/2* inch thick with homogeneous color throughout, constructed from High Density Polyethylene (HDPE) resins. Locker bench tops shall be fabricated from polymer resins compounded under high pressure, forming a single component which is waterproof, nonabsorbent and has a self–lubricating surface that resists marks from pens, pencils, markers and other writing instruments. All plastic components shall be covered with a protective plastic masking.

C. Color of bench to be as shown on finish schedule or as selected by the Engineer.

D. Locker room bench tops shall be 1–1/2–inch thick with all edges rounded to a 1/4–inch radius. Standard bench top size is 24 inches wide by 48 inches for a single piece.

E. Aluminum pedestals shall be 16 inches high, and secured to the bench tops with stainless steel, #14 Phillips head screws and secured to the floor using lead expansion shields and stainless steel, Phillips head screws.

F. Bench to have warranty against breakage, corrosion, and delamination under normal conditions for 15 years from the date of receipt by the customer. If materials are found to be defective during that period for reasons listed above, the materials will be replaced free of charge (Labor not included in warranty).

2.04 PORTABLE FIRE EXTINGUISHERS

A. General:

1. Conform to NFPA 10 for fire extinguishers.
2. Furnish fire extinguishers and cabinets from one manufacturer.
3. All Extinguishers: UL listed, charged and ready for service.

B. Multipurpose Hand Extinguisher (F. Ext–I):

1. DuPont FE–36 Clean Agent extinguishing agent.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Agent propelled through hose or opening at top of unit.
5. For use on A, B, and C class fires.
6. Minimum UL Rating: I–A: 10–B:C, 9.5–pound capacity.

C. Manufacturers: Ansul CLEANGUARD.

PART 3 - EXECUTION

3.01 INSTALLATION OF SPECIALTIES

A. Follow manufacturer's recommendations and printed instructions. Consult with Engineer so that minor adjustments in the locations can be decided if necessary.

1. Install materials plumb or level as applicable and attach securely to adjacent materials with suitable fasteners.
2. Prevent scratching or damaging adjacent materials during installation.

B. Installation of Toilet and Bath Accessories:

1. Preparation: Coordinate support framing and backing as necessary for the proper installation of all accessories.

2. Installation:

   a. Locate where mark is shown on Drawings at height as indicated on Drawings or required by code.
   b. Follow manufacturer's instruction and recommendations.
   c. Install and securely anchor all accessories in their proper locations, plumb and level and without distortion.
   d. Remove all protective masking and clean surfaces, leaving them free of soil and imperfections.
   e. Fill all units with necessary supplies within 10 days before Substantial Completion.
   f. Deliver to Owner all keys and devices required to fill and service units.

C. Lockers and Benches:

1. Examine areas to receive the locker room benches for anchorage blocking that may affect installation of benches or lockers. Report any discrepancies to the engineer.
2. Take complete and accurate measurements of locations to receive locker room benches.
3. Install locker room benches and lockers in a rigid, straight, plumb, and level manor, with plastic laid out as shown on shop drawings and manufacturer's installation instructions.
4. No evidence of cutting, drilling, and/or patching shall be visible on the finished work.
5. Finished surfaces shall be cleaned after installation and be left free of all imperfections.
6. Install lockers at the location shown in accordance with the manufacturer's instructions for plumb, level, rigid, and flush installations.
7. Anchor the units to wall studs through the locker back and to the floor using l–1/2–inch pan head screws. Furring must be installed between lockers and wall of installation.
8. Lockers can be either floor–mounted or installed on a 4–inch high base. Hardware and instructions for either method shall be provided by the manufacturer.
9. Number plates shall be available for field mounting.

D. Fire Extinguishers:

1. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.

    a. Metal expansion shields for machine screws at concrete and masonry.
    b. Interior: Rust–resistant.
    c. Exterior: Stainless steel.
    d. Brackets: For all hand extinguishers not located in cabinets, furnish heavy–duty brackets with clip–together strap for wall mounting.
    e. Provide adequate backing for mounting surfaces.
    f. Install top of Extinguisher: No more than 54 inches above floor.

END OF SECTION

SECTION 12 21 13

HORIZONTAL LOUVER BLINDS

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. This Section includes the following types of blinds and accessories:

1. Horizontal louver blinds with polymer slats.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

B. Shop Drawings: Show location and extent of horizontal louver blinds. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other Work, operational clearances, and relationship to adjoining work.

C. Samples for Verification: For the following products, prepared on Samples from the same material to be used for the Work.

1. Louver Slat: Not less than 12 inches long.

D. Window Treatment Schedule: Include horizontal louver blinds in schedule using same room designations indicated on Drawings.

E. Product Certificates: For each type of horizontal louver blind product, signed by product manufacturer.

F. Maintenance Data: For horizontal louver blinds to include in maintenance manuals. Include the following:

1. Methods for maintaining horizontal louver blinds and finishes.
2. Precautions about cleaning materials and methods that could be detrimental to finishes and performance.
3. Operating hardware.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain horizontal louver blinds through one source from a single manufacturer.

B. Fire-Test-Response Characteristics: Provide horizontal louver blinds with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Resistance Ratings: Passes NFPA 701.

C. Corded Window Covering Product Standard: Provide horizontal louver blinds complying with WCMA A 100.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver blinds in factory packages, marked with manufacturer and product name, and location of installation using same room designations indicated on Drawings and in a window treatment schedule.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 HORIZONTAL LOUVER BLINDS, POLYMER SLATS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Comfortex Window Fashions.
2. Hunter Douglas.
3. Levolor.
4. Springs Window Fashions Division, Inc.

B. Slats: Lead-free, UV-stabilized, integrally colored, opaque, permanently flexible, extruded PVC or polymer/wood alloy that will not crack or yellow; antistatic, dust-repellent treated; with manufacturer's standard profile.

1. Width: 2 inches.
2. Spacing: Manufacturer's standard.
3. Slat Finish: Color as indicated on Drawings.

C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends.

D. Bottom Rail: Manufacturers standard; with enclosed and protected ladders and tapes to prevent contact with sill.

E. Tilt Control: Consisting of enclosed worm gear mechanism and linkage rod, for the following operation.

1. Tilt Operation: Cord-operated tilter.

F. Lift Operation: Manual, cord lock; locks pull cord to stop blind at any position in ascending or descending travel.

G. Mounting: As indicated on Drawings, mounting permitting easy removal and replacement without damaging blind or adjacent surfaces and finishes; with spacers and shims required for blind placement and alignment indicated.

1. Provide intermediate support brackets if end support spacing exceeds spacing recommended by manufacturer for weight and size of blind.

H. Colors, Textures, Patterns, and Gloss: As selected by Architect from manufacturer's full range.

2.2 HORIZONTAL LOUVER BLIND FABRICATION

A. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.

B. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Blind Units Installed between (inside) Jambs: Width equal to 1/4 inch per side or 1/2 inch total, plus or minus 1/8 inch, less than jamb-to-jamb dimension of opening in which each blind is installed. Length equal to 1/4 inch, plus or minus 1/8 inch, less than head-to-sill dimension of opening in which each blind is installed.

C. Installation Brackets: Designed for easy removal and reinstallation of blind, for supporting headrail, and operating hardware, and for hardware position and blind mounting method indicated.

D. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to blind hardware and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

E. Color-Coated Finish:

1. Metal: For components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

F. Component Color: Provide rails, cords, ladders, and exposed-to-view metal and plastic matching or coordinating with slat color, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HORIZONTAL LOUVER BLIND INSTALLATION

A. Install blinds level and plumb and aligned with adjacent units according to manufacturer's written instructions, and located so exterior louver edges in any position are not closer than 2 inches to interior face of glass. Install intermediate support as required to prevent deflection in headrail. Allow clearances between adjacent blinds and for operating glazed opening's operation hardware, if any.

B. Jamb Mounted: Install headrail flush with face of opening jamb and head.

C. Install horizontal louver blinds at window in Bathroom.

3.3 ADJUSTING

A. Adjust horizontal louver blinds to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean blind surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.

C. Replace damaged blinds that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

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SECTION 12 35 53

LABORATORY CASEWORK

PART 1 – GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI):

   a. A135.4, Basic Hardboard.
   b. Z358.l, Emergency Eyewash and Shower Equipment.

2. Americans with Disabilities Act (ADA).
3. APA-The Engineered Wood Association (APA): Grades and Specifications.
4. Architectural Woodwork Institute (AWl): Architectural Woodwork Quality Standards.
5. ASTM International (ASTM):

   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A507, Standard Specification for Steel, Sheet and Strip, Alloy, Hot-Rolled and Cold-Rolled, Drawing Quality.
   c. A666, Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   d. C1048, Standard Specification for Heat-Treated Flat Glass Kind HS, Kind FT Coated and Uncoated Glass.
   e. D1193, Standard Test for Reagent Water.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

6. National Electrical Manufacturer's Association (NEMA):

   a. LD 3, High Pressure Decorative Laminates (HPDL).
   b. WD 1, General Requirements for Wiring Devices.

7. National Institute of Standards and Technology (NIST), Product Standard Section: PS 1, Construction and Industrial Plywood.
8. National Fire Codes-National Fire Protection Association (NFPA):

   a. 30, Flammable and Combustible Liquids, Section 4-3.
   b. 45, Fire Protection for Laboratories Using Chemicals.
   c. 70, National Electrical Code (NEC).

9. Occupational Safety and Health Administration (OSHA): General Industry Standards, Section 1910.106.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Completely describe and illustrate design features, materials, fabrication, and casework layout including rough-in details for plumbing, electrical, and ventilation connections.

    a. Key units to Contract Document designations.
    b. Provide details and dimensions not controlled by job conditions.
    c. Show required field measurements beyond manufacturer's control.
    d. Establish and maintain applicable rough-in and field dimensions.
    e. Descriptive literature and manufacturer's specifications of casework, hardware, service fixtures, and specialty items.
    f. Brochures, catalogs, installation instructions, and operations and maintenance manuals.
    g. Clearly mark with Contract Document designation each proposed item in manufacturer's literature.
    h. Coordinate Shop Drawings with other trades.
        1. Seismic anchorage and bracing drawings and data sheets, as required by manufacturer.
        2. Samples:
            a. Finished color Samples of each finish proposed by casework manufacturer.
            b. Sample unit, complete with hardware, including locks, accessories, and top for Owner's inspection and 1 month's use. Unit, except top, may be used on Project.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by code and casework manufacturer.
2. Qualifications of manufacturer and installation lead person.

1.03 QUALITY ASSURANCE

A. Standards:

1. Casework: Conform to "Architectural Woodwork Quality Standards" of Architectural Woodwork Institute (AWI), Premium grade.

B. Casework Manufacturer Qualifications:

1. Reputation for doing satisfactory work on time.
2. Successful completion of comparable work.
3. Specialization in design and manufacture of plastic laminate casework or furnishings for scientific laboratories.
4. Operation of adequate size factory devoted to manufacture of plastic laminate laboratory casework or furnishings.
5. Minimum 5 years' experience in manufacture of quality and type of laboratory casework and furnishings specified.
6. Warranty is for 3 years from date of installation.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver materials to Project Site until excessive moisture is out of building for at least 10 days.

B. Store casework inside in dry and well-ventilated areas, and do not subject to extreme changes in temperature or humidity.

C. Coordinate delivery and installation with Engineer. Owner may wish to inspect items in Contractor's presence to verify condition.

PART 2 – PRODUCTS

2.01 CASEWORK MANUFACTURERS

A. Plastic laminate faced casework of the following manufacturers, meeting these Specifications, may be used on this Project:

1. LSI Corp., Minneapolis, MN.
2. Campbell Rhea, Paris, TN.
3. Nolen Products, Knoxville, TN.
4. Laboratory Design & Supply, Buford, Ga.; basis of design. Phone 813/986-0499.

2.02 CASEWORK MATERIALS

A. Plywood: APA exterior type conforming to NIST, Product Standard Section, PS 1.

1. Thickness: Minimum 3/4 inch.
2. Grade: No knots or voids present on surfaces. Use marine grade for cabinet bases or pressure treated wood.

B. Hardboard:

1. Wood fibers and resin binder molded under high pressure.
2. Thickness: Minimum 1 – 1/4 inch.
3. Premium grade.
4. Tensile Strength: 3,500 psi.
5. Shear Strength: 4,500 psi.
6. ANSI A135.4, Type II, Surface 2, Finish A, Design A.

C. Plastic Laminate:

1. High-pressure plastic laminate for Special Cabinets defined in Article Casework Fabrication of this section, excluding counter tops.
2. Thickness: 0.051 plus or minus 0.005 inch.
3. Stain Resistance: Show essentially no effect for materials I through 23 and moderate effect for materials 24 through 29 when tested according to NEMALD3.
4. Finish and Color: As shown in Interior Finish Schedule.

5. Manufacturer and Product: Wilsonart; Tufsurfll.

D. Edge Banding:

1. Minimum 3-mm thick polyvinyl chloride for drawer and door fronts and cabinet box.
2. l-mm edging on all other edges.
3. Color: Selected by Engineer from manufacturer's standard colors.

E. Hardware:

1. Door Locks: BHMA A156.11, E07121; keyed to match existing locks.
2. Drawer Locks: BHMA A156.11, E07041; keyed to match existing locks.
3. Hinges: Concealed type, minimum 120-degree opening with spring closer.
4. Pulls: Manufacturer's standard semi flush type of molded ABS plastic in color selected by Engineer from manufacturer's standard colors.
5. Shelf Fasteners: Metal or plastic design providing rigid and true shelf alignment.
   - Metal: Dull chrome finish.
   - Plastic: Match cabinet interior color.
6. Drawer Slides: Epoxy coated.
   - Metal designed to mate with drawer slides in cabinets.
   - Provide smooth sliding action.
   - Load Support on Extended Drawer: 150 pounds in file drawers, 75 pounds in drawers 6 inches and less in depth, and 100 pounds in other drawers.

F. Accessories: Manufacturer's standard catches, grommets, and other accessories and trim required to complete installation in secure and rigid manner. Finish to match other exposed hardware.

G. Adhesives: Manufacturer's standard water-resistant adhesives.

H. Counter Tops: To match RO Plant.

1. Epoxy Resin at Lab Area:
   a. Molded, modified, solid epoxy resin.
   b. Formulated to produce smooth, nonabsorbent, chemical-, heat-, and shock-resistant surface.
   c. Homogeneous in color and texture.
   d. Thickness: Minimum 1 inch.
   e. Drip groove under front edge.
   f. Integral two-piece glued backsplash for full length of adjoining walls.
   g. Color: Black
   h. Manufacturers and Products:
      1) Durcon; Durcon Resin.
      2) Laboratory Tops; Epoxy Resin.
      3) Prime; Prime-Resin.

2. Plastic Laminate at Work Station.

   a. Finish and Color: As shown in Interior Finish Schedule.

I. Backsplashes, Backsplash Returns, Splash Curbs (SCB), Reagent Shelves, and Reagent Shelf Supports: Same material as adjacent counter top.

J. Electrical installation and materials shall comply with the requirements of Division 26, Electrical.

2.03 LABORATORY EPOXY RESIN SINK LSK-I (IF SHOWN ON PLANS)

A. Description:
1. Single Compartment: One-piece, molded epoxy resin with coved corners and corner outlet.
2. Size: 24 inches long by 16 inches wide by 8 inches deep interior dimensions.
3. Epoxy resin sink drain outlet complete with removable strainer, stopper, and 1 – 1/2-inch tailpiece.

B. Manufacturers and Products: Drop-In Type Sink: Durcon; Model No. D-55.

2.04 LABORATORY SERVICE FIXTURES

A. General: Protect chrome plumbing service fixtures with white epoxy enamel coating applied by manufacturer's electrostatic powder coating process.

B. Deck Mounted Mixing Faucet LP-I:

1. Swing gooseneck with 8-inch spread, vacuum breaker, and removable aerator.
2. Index for hot and cold water.
3. Manufacturers and Products:
   a) Chicago; Model No. 930 with 8-inch spread.
   b) Water Saver; Model No. L-4I2-8VB.

2.05 CASEWORK FABRICATION

A. Construct casework of plywood covered with laminated plastic sheets on both surfaces.

B. Furnish manufacturer's standard modular units conforming as closely as possible to dimensions shown on Drawings, or specially made casework units where standard sized units do not conform to dimensions and configurations shown on Drawings.

C. Construct casework with face screwed fasteners. Do not depend on mechanical fastening, gluing, or screwing of core edges for strength.

D. Excluding countertops, fabricate cabinet surfaces (fronts, backs, sides, tops, bottoms, shelves, doors, drawer fronts, bases, and fillers) with minimum 3/4-inch thick plywood covered with plastic laminate on both sides bonded by polyester resin at high pressure and temperature. Seal and protect cabinet and drawer surfaces from water intrusion. Drawer and door fronts to be covered with Chemical Resistant laminate. Drawer bottoms are to be wood-laminate is not

acceptable. All backs are to be removable; 3-mm edge on drawers, doors and cabinet box; l-mm edge on all other edges.

E. Radius exposed corners at least 1-1/4 inch.

F. Protect edges from water intrusion including edges not exposed to view, e.g. resting on base, sitting on floor, standing behind cabinet. Install vinyl edges on exposed edges of cabinets, doors, and drawers. Locate joints in vinyl edges where least noticeable. Bond under pressure with waterproof hot melt glue and finish with smooth, radiused edges, and corners.

G. Cabinet Bases:

1. Design and construct separately from side and back panels to support cabinets rigidly in true alignment.
2. Material: Marine grade exterior plywood or treated wood.
3. Height: 4 inches.
4. Install adjustable leveling feet at each corner and at intermediate points necessary for rigid support.

H. Backsplashes and Splash Curbs: Field glued.

I. Access Panels: Removable units opening to pipe space behind cases at knee spaces, balance tables, ends of islands and peninsulas, and elsewhere for access.

J. Sliding Glass Doors: Frameless type in wall-mounted or double-sided island or peninsula-mounted cases. Framed type for tall storage cabinets and base cabinets.

K. Cabinet Locks CLK: Doors and drawers where shown on Drawings.

L. Color: Countertops, fronts, trim, and other exposed surfaces as selected by Engineer from manufacturer's standard colors

M. Wood Drawers: Construct in accordance with AWI Premium.

N. Flammable Liquid or Acid Storage Cabinets, *F/A:*

1. Fabricate in length, width, and height shown on Drawings according to Flammable Liquid or Acid Storage Cabinet Detail.
2. Construct in accordance with regulations:
   a) OSHA, Section 1910.106.
   b) NFPA 30, Section 4-3.
3. 1-inch APA exterior grade plywood around, rabbeted joints fastened in two directions with flathead wood screws, and rabbeted overlap of at least 1 inch when two doors are shown on Drawings.
4. Self-closing doors and means of latching.
5. Hinged to hold when subjected to fire.
6. Raised sill in bottom capable of holding 2-inch depth of spilled liquid.
7. Shelf to limit maximum containers capacity to 1 gallon, in accordance

with NFPA 45, Section 7.2.3.
Label cabinet laminate front "Acids Only".

8. Except for BCV, no penetrations for plumbing, electrical, or other utilities.

PART 3 – EXECUTION

3.01 INSPECTION AND PREPARATION

A. Make field measurements of items or conditions affecting casework, equipment, and furnishings.

B. Examine grounds and supports of casework to assure adequate anchorage, free of foreign material, moisture, and unevenness that would prevent quality casework installation.

C. Verify that ventilation outlets, service connections, and supports are correct and in proper location.

D. Identify and correct defects before proceeding with installation.

3.02 INSTALLATION

A. Use proper type of anchoring devices for materials encountered.

B. Install in accordance with manufacturer's instructions.

C. Except where noted, install in new and ready-to-use condition.

D. Cut, fit, patch, and provide support where required for proper and complete installation.

E. Casework:

1. Secure casework in place in true alignment, level, and plumb. Secure casework units to cleats anchored to building structure or wall framing. Install wall-hung cabinets to firmly and rigidly support cabinet weight plus normally expected cabinet content weight.
2. Fasten together adjoining cabinets in an assembly joined at top and bottom of front and back with bolts placed inconspicuously inside cabinets.
3. Close exposed-to-view openings larger than joints with filler of same material and finish as adjacent casework. Secure filler to casework with concealed screws. Use minimum width and number of fillers consistent with need. Except where shown on Drawings, do not use filler panels (FPL) exceeding 6-inch width.
4. Install cabinet front face 3 inches in front of cabinet base face to provide toe space.

F. Countertops:

1. Install standing height countertop's working surface 36 inches above

finished floor. Install desk height countertop's working surface 30 inches above finished floor.

2. Install level to within 1/16 inch in 10 feet and in largest possible increments.
3. Where not supported by base cabinets or other furnishings, use brackets or other support on minimum 3-foot centers.
4. Make joints with manufacturer-provided cement containing same color and chemical-resistance characteristics as top material. Leave joints smooth and in same plane as top.

G. Laboratory Sinks and Service Fixtures:

1. Install in countertops and cases in manner recommended by manufacturer.
2. Take care to avoid scratches and other damage to cases and countertops.
3. Install ready for connection of services.

H. Furnishings:

1. Provide equipment with connection terminals for plumbing, gas, steam, electrical, ventilation, and refrigeration service connections where required.
2. Where items are supplied without line cords, furnish line cord and plug compatible with electrical service and available outlets.

3.03 ADJUSTING AND CLEANING

A. Adjust hardware and leave in smooth, easy condition. Remove protective maskings. Clean surfaces ready for use. Restore stained or discolored finishes or replace item.

B. Inspect, adjust, clean, and test service fixtures to assure intended operation.

END OF SECTION

INDEX TO

SECTION 25 50 00

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

SECTION 25 50 00

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

PART 1 – GENERAL

1.01 SCOPE OF WORK:

A. Attention is drawn to the requirement that all Supervisory Control and Data Acquisition (SCADA) equipment required shall be furnished by the same System Integrator or System Supplier (these terms are used interchangeably throughout).

B. System supplier shall furnish all labor, materials, equipment, and services required to install and place into operation the equipment and controls specified herein, as shown on the Contract Drawings and as needed to provide a fully functional system.

C. Any auxiliary devices such as lightning/surge protectors, relays, timers, isolators, signal boosters, etc., which are necessary for complete operation of the system, or to perform the functions specified, shall be included.

D. System Suppliers shall coordinate programming of the programmable logic controllers with the equipment suppliers, chemical feed pump suppliers, motor control center supplier, MBR supplier, and all other related equipment supplied by a vendor.

E. Special devices used in programming supplied hardware shall be provided. It is the intent that the Owner shall have the full capability to re-program and modify any application on-site without the need to purchase any additional hardware or software.

F. The System Integrator shall be responsible for the satisfactory design, installation, programming, and commissioning of a complete and fully operational SCADA system that fully complies with the specifications within this document and regulatory requirements.

G. The Contractor shall include in their price, two scheduled maintenance trips for review and calibrations of the supplied system over the warranty period. Maintenance trips shall be one, eight-hour day with the first being scheduled six months after substantial completion or commissioning, as selected by the Owner, and the second being twelve months from the same date. All costs associated to these two days shall be included in the Contractors bid. Service shall be performed by qualified service technicians.

1.02 QUALIFICATIONS

A. System Supplier shall coordinate fully with the Owner needs.

B. System Supplier shall be a licensed Electrical Contractor in the state of SC.

C. System design shall be reviewed and approved by a Registered Professional Engineering firm in the state of SC.

D. System Supplier shall be regularly engaged in the type of work called for and have the resources to successfully execute the work. Resources shall be defined as capital facilities, personnel, and service. System Supplier shall have successfully completed the installation of control systems of a similar magnitude and complexity and be able to furnish experience records and personnel contacts for each installation upon request.

E. The System Supplier shall be responsible for the detailed design, technical supervision for installation, field connections to equipment, and the proper functioning of the SCADA system to be furnished under these Specifications.

F. The System Supplier shall also have in his employ, permanent field service organization capable of providing the service and maintenance of the system.

G. The System Supplier must have a field service location with a full-time staff located within less than 150 miles of the site.

H. All of the equipment shall be of latest and proven design. The system shall be expandable to include future sites and equipment, and shall be non-proprietary such that future equipment could communicate with installed equipment.

I. Qualifications Statements: The personnel or subcontractors must have a minimum of five years of experience in the design, programming, and start-up of SCADA systems.

1.03 SUBMITTAL REQUIREMENTS

A. Submit proposed hardware and software products.

1.04 SPARE PARTS

A. Spare parts shall be provided for all components so there is one spare for every five like items or part thereof.

B. All spares shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity and temperatures.

C. Storage and handling instructions shall be provided with each spare part.

D. One year's supply of paper, ink cartridges, calibration equipment, etc., as required for the equipment being supplied, shall be provided. Items with less than one year's shelf life shall be provided at required intervals to ensure reliable systems operation throughout the first year following system acceptance.

1.05 SITES

The following sites are to be included in this system:

A. Wastewater Treatment Plant

1. SCADA Servers: Computer based SCADA system complete with custom

graphic screens and tag development, running on a Windows based computer. Contractor shall provide a primary SCADA server with a fully redundant secondary SCADA server.

2. Main Plant SCADA Panel consisting of a PLC and appurtenant devices to monitor and control the plant and associated devices, chemical systems, flow monitoring, the wastewater treatment process, the generator, etc.

3. Plant Control Network consisting of Copper Ethernet communications within buildings and Fiber Optic Ethernet communications between buildings to interconnect all control components located on the Treatment Plant site.

B. Field Sites

1. Effluent Pump Station RTU Panel consisting of a PLC, Radio, and related for level monitoring and appurtenant devices to monitor the level of water in the Effluent Pump Station Wet Well, control, and monitor the effluent pumps, control the irrigation zones, and related.

1.06 FUNCTIONAL DESCRIPTION OF CONTROL SYSTEM

A. General Programming Requirements:

1. All logic, data conversion, arithmetic, and control routines shall be programmed in the PLC located in the RTU itself and not in the SCADA software. The intent of this specification is that the SCADA software shall poll the PLC for all incoming data values and that minimal logic, data conversion, arithmetic, and control routines shall be programmed into the SCADA software. Any and all adjustments to operating Set points and parameters may be limited by the System Supervisor or Plant operator using the login and password security on the SCADA system, giving each operator a specific and appropriate level of control on the system.

2. Where requested by the Owner, all input, output, and data points, collected or controlled, at each SCADA panel shall also be communicated, recorded, displayed, or made available as an alarm at the SCADA server.

B. Plant Site Fiber Optic Communications Network:

1. Provide and install a multimode fiber optic network to connect the following sites to the SCADA system:

a. SCADA Server.
b. Main Plant SCADA Panel.
c. Chlorine Contact Basin.
d. Generator.

C. Remote Site Wireless Communications Network:

1. Design, provide, and install a private radio network to connect to the

following sites to the SCADA system:

a. Effluent Pump Station.

D. Remote SCADA Access – Firewall and Network Security System:

1. Provide and install a secure Firewalled remote access gateway to allow Operators with proper security credentials to view and operate the SCADA system over remote client connections.

PART 2 – PRODUCTS

2.01 GENERAL

A. SCADA Panel Equipment

1. Enclosures:

a. Enclosures mounted outdoors shall be UL Listed Type 4X Stainless Steel with quarter-turn latches, including a means for padlocking the enclosure. Due to the corrosive environment, enclosures mounted indoors shall also be also be UL Listed Type 4X Stainless Steel with quarter-turn latches. The enclosure must be sized appropriately for equipment, environment, installation, and maintenance access.

b. Enclosures mounted outdoors shall be mounted under an aluminum sun and weather shield sized appropriately to protect the enclosure and provide maintenance access.

c. Enclosures shall be securely mounted to walls for indoor installations. For outdoor, installs shall include weather shields and equipment racks using manufacturer recommended mounting feet and mounting strut as required.

d. All enclosures must include a laminated set of schematic drawings permanently affixed to the inside of the enclosure door which completely describe all internal and field wiring to the panel.

2. Programmable Logic Controllers (PLC):

a. PLCs shall be modular rack mounted industrial type mounted to DIN style mounting rails.

b. All PLCs supplied under this contract shall be interoperable, supplied from the same manufacturer, and be able to be programmed using the same programming software suite.

c. PLC processors shall be programmed using IEC 61131-3 programming languages and final control programs shall be supplied on CD-ROM with O&M manuals.

d. All wiring to PLC modules shall be by means of pluggable terminal blocks secured by retaining screws to facilitate replacement of modules.

e. All inputs and outputs to the PLCs shall be isolated from field wiring; discrete inputs and outputs shall be isolated using control relays and analog inputs and outputs may be isolated using approved analog isolation described below.

f. PLC power supplies shall be 120VAC powered.

g. Each PLC shall be capable of accommodating twenty percent additional I/O modules without need of additional racks or power supplies.

h. PLC hall operate in an ambient temperature of 0-60 degrees Celsius and a relative humidity of 5-95 percent, non-condensing.

i. PLCs shall be as manufactured by Allen-Bradley, GE, Siemens, or approved equivalent.

3. Operator Interface Terminals (OIT):

a. An operator interface terminal shall be provided for each PLC panel and shall be programmed with custom screens to display information relevant to the specific terminals shall also provide password protected access to setup screens which allow configuration parameters to be set for the control loops programmed into the PLC. Operator interface terminals shall be 24VDC powered and be connected to their respective PLCs via Ethernet, Serial, or USB interface using PLC native communication protocols. OITs shall be mounted on the front of enclosures mounted indoors, or inside enclosures mounted outdoors. OITs shall be a minimum of three-inch color touch screen devices.

b. OITs shall be as manufactured by Allen-Bradley, Automation Direct, or approved equivalent.

4. Analog Isolators:

a. Analog isolators shall be provided for each analog input or output from the PLC that is connected to a circuit that leaves the control panel enclosure.

b. Isolators must provide full electrical isolation between field and internal panel components. For two-wire or three-wire transducers that require voltage sourcing from the control panel, the isolator must provide full three-way electrical isolation between the power supply source, the PLC, and the field wiring.

c. Analog isolators shall be as manufactured by Allen-Bradley, Edco,

Phoenix Contact, or approved equivalent.

5. Control and Interposing Relays:

   a. Interposing relays shall be provided for each discrete input or output from the PLC that is connected to a circuit that leaves the control panel enclosure, and other circuits as appropriate.

   b. Relays shall have a DIN-Rail mounted based with plug-in field-replaceable relay with segregated coil and contact terminals.

   c. Relays shall be equipped with LED indicators and coil suppression modules.

   d. Relays shall be provided with minimum 6A rated contacts with coil voltages as required.

   e. Control relays shall be as manufactured by Allen-Bradley, Phoenix Contact, or approved equivalent.

6. DC Power Supplies:

   a. DC Power supplies shall be UL Listed industrial power supplies and marked for use at 100 percent capacity. Voltage and current shall be as required for the panel capacity.

   b. DC Power supplies shall be as manufactured by Allen-Bradley, Phoenix Contact, or approved equivalent.

7. Uninterruptible Power Supply:

   a. Each SCADA panel shall be equipped with a 120 volt AC cord and plug connected UPS sized to provide a minimum of 30 minutes of back-up power for the entire panel and any external devices sourced from the panel.

   b. The UPS shall be as manufactured by APC, Cyberpower, Sola-HD, or approved equivalent.

8. Terminal Blocks:

   a. All field wiring shall be provided with screw-terminal, DIN-Rail mounted terminal blocks.

   b. Terminal blocks for power and discrete signal wiring must be able to accommodate one 10AWG stranded copper conductor or two 14AWG stranded copper conductors.

   c. Terminal blocks for analogue signals shall either be multi-level type incorporating a ground clamp foot for termination of cable shield, or shall be single level blocks grouped in an arrangement so that the signal wires and shield from each signal cable are terminated

on adjacent blocks. Shield wires should be terminated on ground clamp type terminal blocks to make electrical contact with DIN Rail mounting.

d. Every terminal block in the panel shall bear printed labels both on the field and internal wiring sides of the block. Handwritten labels will not be acceptable.

e. Terminal blocks shall be as manufactured by Allen-Bradley, Phoenix Contact, or approved equivalent.

9. Surge Suppression:

a. All panels shall be provided with surge suppression for the incoming 120VAC power connection. Surge Suppressors shall be multi-stage type with an LED indicator, and may be installed as either series or parallel devices per manufacturer recommendations. Surge suppressors shall ground surges up to 5,000 volts.

b. Surge Suppressors shall be as manufactured by Intermatic, Phoenix Contact, SOLA-HD, or approved equivalent.

B. Communications

1. Plant Control Network Scope of Work:

a. The plant control communications networks shall consist of an industrial Ethernet network involving:

1. Next Generation Firewall Appliance.
2. Industrial Ethernet router.
3. Industrial Ethernet switches.
4. Multimode fiber optic cable.
5. CAT5E/6 Ethernet Cable for SCADA computer to Main Plant PLC.
6. All devices supplied under this contract shall support 100Mbit per second full-duplex communication minimum.
   a.

b. The plant fiber network shall be supplied, installed, terminated, and programmed by the contractor.

2. Documentation:

a. The Systems Integrator shall submit a proposed network diagram including all nodes and links between nodes, with descriptions of proposed addressing schemes and any network or device configuration information with the system submittals. At commissioning, the Systems Integrator shall supply an As-Built network diagram providing all of the information above as well as any other pertinent network information with the system O&M

manuals.

3. Components:

a. Next-Generation Firewall Appliance: The system shall be supplied with a Next Generation Firewall Appliance (NGFW) to secure the connection between the network control system and the customer supplied internet access point. All communications between the network control system and the customer supplied internet access point shall pass through the NFGW. The NGFW shall be configured by CSI to prevent all incoming and outgoing traffic except for authorized remote access by the customer's employees and representatives. This configuration shall be done according to current network control system cybersecurity guidelines and best practices. Prior to configuring the NGFW and other equipment in the network control system, the CSI shall perform a customer and site specific risk assessment and shall use this as a guideline for implementation to mitigate all risks which are likely to occur and have a major impact on the system.

1. The NGFW Appliance shall have at least three copper Ethernet ports capable of 1Gbps throughout, and which can be configured so that any traffic between any or all ports can be restricted or allowed according to the configuration of the device.

2. If the NGFW is equipped with multiple LAN side ports and is configured to switch traffic between those ports without exposing the connected devices to the WAN, then it shall be permitted to use the NGFW as a switch in the network control system if appropriate.

3. If the NGFW is equipped with 802.11 wireless networking, this feature shall be disabled.

4. The NGW shall be equipped with a protocol aware stateful deep packet inspection type firewall, able to discriminate between the traffic allowed on the system and traffic not allowed on the system.

5. The NGFW shall also be equipped with VPN capability to provide additional security for remote access.

6. If licensing or maintenance subscription is required to maintain the protection level of the NGFW, the CSI shall be responsible for paying all associated fees through the end of the warranty period. The CSI shall coordinate all maintenance and upgrades with the ORC and customer's IT representative.

b. Industrial Ethernet Router: The router shall be an industrial type DIN-rail mounted device powered by an industrial 24VDC power

supply. Power supply wiring shall be to plug-in screw terminal type terminal blocks. Devices using plug-in transformers or pig-tail type plugs will not be acceptable. Network connection to the device shall be by standard RJ45 ports connection to CAT 5E twisted pair cable. The router shall have an internal configurable stateful inspection firewall, DHCP server, and NAT routing including port forwarding, and support blacklist and whitelist filtering of specific PAC and IP addresses, ports, and protocols. The router shall provide protection against IP spoofing, DoS, and Flood attacks. The router shall support web-based management via HTTPS and SNMP from the internal network only. The router shall be located in the Main Plant SCADA panel, adjacent to and connected to the Ethernet switch located in the panel. The router shall provide the only connection between the Plant Control Network and the Internet. Router shall be as manufactured by Allen-Bradley, Hirschman, Phoenix Contact, or an approved equivalent.

c. Industrial Ethernet Switches: Ethernet switches shall be industrial type DIN-Rail mounted devices powered by an industrial 24VDC power supply. Power supply wiring shall be plug-in screw terminal type terminal blocks. Devices using plug-in transformers or pig-tail type plugs will not be acceptable. Switches may be either managed or unmanaged type store-and-forward switches. Network connection to the device shall be by standard RJ45 ports connecting to CAT5E twisted pair cable for copper connections, or by standard SC or ST duplex connectors for multimode fiber optic connections. An Ethernet switch shall be located in each panel supplied for the Plant site. All switches supplied under this contract shall be identical. All switches shall have a minimum of two duplex fiber optic ports per switch, and the sufficient RJ45 copper ports to connect all available equipment in the respective panel plus an available port for maintenance. The switch located in the Main Plant SCADA panel shall also have two connections available for SCADA computers, one for the computer supplied with his project, and one for future expansion. Switches shall be as manufactured by Allen-Bradley, Hirschman, Phoenix Contact, or approved equivalent.

d. Fiber Optic Cable: Fiber optic cable shall be 50um or 62.5um multimode cable designed for indoor and outdoor use, rated for use in general purpose, riser, aerial, duct, and direct-buried applications. Fiber optic strands shall be color coded and tight-buffered within the cable and not require a fan-out kit of transition splicing for termination. Fiber optic cable water blocking shall be gel-free. Maximum attenuation shall be 3.4B/km. Fiber optic cables supplied under this contract shall have a minimum of three pairs of fibers per cable and shall be terminated with either SC or ST type connectors at the System Integrator's discretion; however, all connectors used in this contract shall be the same type, either SC or ST. All network links which extend outside of a building or structure shall use fiber optic cable. Copper network cables shall not extend outside any building or structure. Careful attention

shall be paid to not damage the fiber optic cable during installation; all pulling, bend, and conduit for fiber optic cable shall be per manufacturer's recommendations. Any fiber optic cable which is damaged by installation shall be removed and replaced in its entirety. No splices shall be permitted in fiber optic cables. Fiber optic cable shall be as manufactured by Belden, Corning, Mohawk, or approved equivalent.

e. Copper Ethernet Cable: Copper Ethernet cables shall be a minimum CAT5E twisted pair type with RJ45 connectors with snag less boots. Patch cables used within control panels shall be minimum 24AWG, pre-terminated patch cables. Network cables extending outside of control panels (e.g. connecting the SCADA computer to the plant network) shall be minimum 24AWG and provided with a proper strain-relief hub or bushing, and may be field terminated. Under no circumstances shall copper Ethernet cables extend outside a building or structure. Copper Ethernet Cables shall be as manufactured by Belden, Black Box, Mohawk, or approved equivalent.

4. Telemetry System Radio Communications Network:

a. Frequency, Radio, and Antenna selection guidelines:

1. Radio frequencies, data radios, and antennas shall be selected based on path and propagation studies that illustrate an unobstructed link between any sending or receiving pairs of antennas. These studies shall accommodate for topography and foliage obstructions. Integrators shall be responsible for conducting or subcontracting these studies. This information shall be used to properly set antenna heights and radio powers in accordance with FCC guidelines.

2. Radios, peripheral hardware, and software selection must be capable of delivering a polling rate of less than two seconds per site with a data fail error of less than ten percent over one hundred consecutive calls to each individual site. The two-second polling rate time constraint begins with the initial poll from the master and ends with a complete, valid reply from the RTU.

3. Antennas shall be properly matched to the selected data radios and be one of two types.

a. Omni (Multi-Directional).
b. Yagi (Uni-Directional).

4. The System Integrator is responsible for obtaining all FCC approvals where applicable. The Integrator shall adhere to all regulations set by the National Electric Code and the Federal Communications Commission (FCC).

5. Radios shall be supplied with a three year Warranty with the System Integrator serving as a single source agent for Warranty issues.

b. Antennas and Appurtenances:

1. For the bidding purposes, Antenna heights shall be thirty feet above grade. Actual antenna height may need to be adjusted following a radio path study. Any additional costs required for height above thirty feet will be the responsibility of the Owner.

2. The System Integrator shall furnish all antennas, complete with support structures, in accordance to the path and propagation studies. The antennas shall be matched to selected radio frequency and characteristics of the data radios.

3. System Integrator shall design and install the antennas based on the path studies.

c. Coaxial cable shall be installed in accordance to the following:

1. Cable runs less than 65 feet and shall be low loss 1/2-inch heliax with foam dielectric.

2. Cable runs greater than 65 feet shall be low loss 7/8-inch heliax with foam dielectric.

d. Installations shall include a grounding kit and polyphaser coaxial protection.

e. Lighting surge protectors shall be provided at each RTU cabinet termination point.

C. SCADA Workstation: A new industrial SCADA Workstation shall be provided with the following minimum requirements:

1. Two 24-inch LED computer monitors with DVI, VGA, and HDMI inputs (per work station).

2. A CPU with the latest available technology equivalents to a fourth generation Intel i7-4790K (8M Cache, up to 4.40 GHz).

3. SCADA computer shall have a minimum of:

a. 16GB of RAM.
b. One HDD (hard disk drive) with a minimum storage capacity of 1TB for Windows OS and data storage.
c. One SSD (solid state drive) with a minimum storage capacity of 250GB for the SCADA software only.

d. DVD+-RW Optical Drive.
e. Two Gigabit Ethernet Network Ports.
f. A 1GB NVIDIA GPU, with a minimum of two video ports (VGA, DVI, or HDMI).
g. One Phone Modem for alarm communications, must be Multi-Tech MT9234ZPX-UPCI (ensure that the model number does not contain "NV" or no voice).

4. UPS (Uninterruptable power supply) of 850VA.

PART 3 – SOFTWARE

3.01 GENERAL

A. When multiple copies are provided if the same package, all versions shall be identical.

B. The System Integrator shall be responsible for providing and installing the software as required.

C. The programming and configuration of the software shall be by the System Integrator similar to the Owners existing software.

D. All software licenses shall be transferred to the Owner prior to system acceptance by the Owner.

E. SCADA Software Suite: Supervisory Control and Data Acquisition (SCADA) Software.

1. The primary server SCADA software shall include both run time and full development capabilities. The secondary server SCADA software shall include runtime capabilities at a minimum.

2. The system shall include: automatic alarm dial out capabilities with phone, email, and text messaging capabilities.

3. The system shall include a minimum of two simultaneous remote internet client connections.

4. SCADA software shall be commercially available off-the-shelf and shall be non-proprietary, such that independent systems integrators are able to provide configuration and maintenance services as required.

5. Software shall be a Client/Server architecture. No Microsoft Client Access Licenses (CAL) shall be required for full installation (thick) or browser-based (thin) clients. Terminal Services shall not be required.

6. Software licenses shall be upgradable for an annual fee such that the client is able to download the current version of the product.

7. Software shall be tag-based and have an integrated development

environment for creation of all aspects of the application.

8. Software shall be compatible with commercially available, off-the-shelf PC hardware running 32 and 64 bit Microsoft Windows client and server operating systems currently available at the time of installation.

9. Software shall not require dedicated server-level PC hardware for any individual system components.

10. Software shall support any computer running a thick copy of the software performing as both an application server and a user interface. Software shall support automatic server failover to an unlimited number of servers.

11. Software shall include the following integrated components. These components shall not require separate software to be installed.

    a. I/O drivers for common industry-standard protocols.
    b. Alarms management and alarms history.
    c. Historian.
    d. Real-time and historical data trend creation.
    e. Report generation.
    f. Application backup and version control.
    g. Security management.
    h. Support for networked applications.
    i. Support for service redundancy.
    j. An object oriented scripting language with debugging tools.

12. The software manufacturer shall offer, at a minimum, the following optional components.

    a. Browser-based thin clients for PCs and Mobile devices.
    b. Alarm notification (e-mail, text message, and voice).
    c. Interfaces for third-party software programs to access data (real-time and historical) and alarms. Such interfaces may include OPC, ODBC, and SNMP.

13. Software shall compensate for deploying the same application simultaneously on a variety of monitor resolutions, while maintaining the aspect ratios of all displays.

14. Software shall support an automatic, orderly shutdown when switching to UPS backup power and power levels drop to a predefined Set point. Software shall support automatically restart to full operation without user intervention.

15. Software shall provide a mechanism to backup and restore the entire application configuration.

16. Software shall include an integrated security system supporting an unlimited number of user accounts, roles, and privileges. System users with appropriate account privileges shall be capable of changing the application configuration without requiring the software supplier's

assistance. No lockout mechanisms or passwords shall be withheld from the final customer.

17. Integrated software help manuals shall be provided to assist operators and maintenance personnel with operation and configuration tasks.

18. Software shall be the latest version of Wonderwork or approved equivalent.

PART 4 – EXECUTION

4.01 INSTALLATION

A. Installation

1. The SCADA System supplier shall furnish licensed electricians to install all conduits, communication cables, RTU's, radio antennas, and final terminations as required for a complete and operational system.

2. All equipment shall be installed according to the manufacturer's recommendations.

3. Outdoor, new installations shall be stable enough to withstand winds up to 120 miles per hour.

4. All mounting hardware shall be corrosion resistant.

5. All installation shall be in accordance with the local electrical codes.

B. Field Calibration

1. All SCADA System components shall be calibrated in the presence of the Owner in accordance with the range and accuracy specified herein.

2. No form of energy shall be turned on to any part of the SCADA System components prior to approval by the Systems Integrator and Owner.

C. SCADA System Startup

1. The SCADA manufacturer shall furnish the services of a qualified technical service representative to perform the supervisory service required during start-up of SCADA System components.

2. Services of a field service technician shall be provided for no less that one eight-hour day for the purpose of placing all equipment into operation.

3. The minimum days specified above do not relieve the manufacturer of providing sufficient service to place the system in satisfactory operation.

D. Training

1. SCADA manufacturer shall furnish the services of a factory representative for no less than one eight-hour day for the purpose of operator training.

2. Training shall be performed on site.

3. Three months after the system has been placed into operation, the SCADA manufacturer shall furnish the services of a factory service representative for one eight-hour day to conduct follow-up training with the Owner's personnel. The follow-up training shall be conducted on-site and consist of reviewing the operation and maintenance of the system. The Owner shall be contacted a minimum of two weeks in advance prior to scheduling the training session to allow proper coordination.

PART 5 – WARRANTY AND SERVICE CONTRACT

5.01 WARRANTY

A. The contractor shall provide a one year warranty on the system. This warranty shall cover defects in material or workmanship.

B. Warranty period shall start on the day of substantial completion and end one year from this date.

5.02 SERVICE CONTRACT

A. The Contractor shall include in their price, two scheduled maintenance trips for review and calibrations of the supplied system over the warranty period. Maintenance trips shall be one, eight-hour day with the first being scheduled six months after commissioning and the second being twelve months from the final commissioning date. All costs associated to these two days shall be included in the Contractor's bid. Service shall be performed by qualified service technicians.

PART 6 – LONG-TERM SUPPORT

6.01 PHONE SUPPORT

A. Scope of Work: Technical phone support for control system equipment: installation, configuration, maintenance, and troubleshooting.

1. Real-time technical phone support by the control system manufacturer shall be available 8 AM-5 PM local time where the support specialist directly answers the call (no call attendants, no call-back). 24x7x365 coverage (includes evenings, weekends, and holidays) shall be available with same-call-access responsiveness or better.

a. Skill Set: Support specialists shall have knowledge of current and legacy software products and related technologies. Includes controllers, drivers, I/O, networks, programming software,

communications, information, and application software.

2. Electronic support shall be available to ftp a file, submit an online request, and download a software update or lookup a tech note.

   a. Current software releases and reactivation codes shall be available for download from the Internet 24x7. Upon request, overnight shipment of update(s) or replacement media shall be available.

3. Support center shall be able to seamlessly dispatch an on-site engineer if problem warrants (specific response times by region).

6.02 ONSITE SUPPORT

A. Field support engineers are to be made available on an as needed, scheduled, or full-time basis to meet the specific user needs and system maintenance strategy.

B. Callout services for repair and troubleshooting labor as needed for system related issues.

C. Extended parts and labor warranty for repair labor (including local travel) and replacement parts for system control equipment and drives for up to five additional years.

D. Preventative maintenance services to perform regular maintenance on system related equipment to prevent potential problems and extend component and system life.

6.03 TRAINING

A. System supplier must provide training programs for multiple job functions on the chosen process control system. These roles include electricians, maintenance technicians, and control systems engineers. The System supplier must provide various training options including online self-directed classes, onsite instructor led training, and offsite instructor led training.

END OF SECTION

DIVISION 26 – ELECTRICAL

260500 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.02 SUMMARY

A. This division of the Specifications, Division 16 000, covers the complete interior and exterior electrical systems as indicated on the drawings or as specified herein. Provide all materials, labor, equipment and supervision to install electrical systems.

1.03 QUALITY ASSURANCE

A. All electrical work shall be in accordance with the following codes and agencies:

1. The National Electrical Code (NFPA 70)
2. The National Electrical Safety Code (ANSI C-2)
3. The Life Safety Code (NFPA 101)
4. The International Building Code
5. Occupation Safety and Health Administration (OSHA)
6. Manufacturer’s written requirements.
7. Regulations of the local utility company with respect to metering and service entrance.
8. Municipal and state ordinances governing electrical work.

B. Material Standards: All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM)
2. Underwriters' Laboratories, Inc. (UL)
3. National Electrical Manufacturer Association (NEMA)
4. Insulated Cable Engineers Association (ICEA)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. National Fire Protection Association (NFPA)
7. American National Standards Institute (ANSI)
8. Manufacturer’s Written Requirements

1.04 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.05 WARRANTY

A. For warranty of work under Division 16, refer to the GENERAL CONDITIONS.

1.06 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans unless indicated on Electrical plans.

C. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Engineer.

D. Equipment layout is based on one manufacturer's product. Where equipment selected by the Contractor for use on the job differs from layout, the Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.07 SUBMITTALS:

A. Shop Drawings and Product Data:

1. The Contractor shall submit for review by the Engineer data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submittals for lighting fixtures shall include Photometric data.
2. Refer to the individual sections for identified equipment and materials for which submittals are required.
3. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES section for required procedures.

B. Record Documents

1. Refer to Division 1 for record documents and related submittals.

1.08 OPERATION AND MAINTENANCE DATA AND INSTRUCTIONS

A. Refer to Division 1 for detail requirements.

B. Printed Material: Provide required printed material for binding in operation and maintenance manuals.

C. Instructions of Owner Personnel:

1. Before final inspection, as designated by the Engineer provide a competent representative to instruct Owner's designated personnel in systems under this division of the specifications. For equipment requiring seasonal operation, perform instructions for other season within six months unless requested otherwise.
2. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
3. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.09 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service. Refer to ELECTRICAL CONNECTIONS FOR EQUIPMENT section for connection requirements.

B. Drawings indicate design loads and voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the Owner. Such adjustment shall be subject to the review of the Engineer.

C. Incidental items not indicated on Drawings or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide a complete system, shall be furnished and installed as though itemized here in detail. This includes connection requirements for air conditioning and refrigeration equipment as outlined by NEC Article 440.

1.10 MECHANICAL SYSTEMS INTERFACE

A. All control wiring for plumbing and heating, ventilating and air conditioning systems shall be installed under Division 16. Review Division 16 specifications and shop drawings for control systems to assure compatibility between equipment furnished under Division 16 and wiring furnished under Division 16.

B. Motor controllers (starters) shall be furnished and installed under Division 16, unless specified to be furnished as an integral component of the equipment. Provide the number and type of auxiliary contacts necessary to interlock the equipment and provide the specified control sequence.

C. Power wiring to all motors and motor controllers and between motors and controllers shall be provided in Division 16.

D. All electric heating equipment shall be provided and installed under Division 15 - HEATING, VENTILATING AND AIR CONDITIONING. Power wiring to all electric heating equipment shall be provided under Division 16 of these specifications.

1.11 SCHEDULING OF OUTAGES

A. Electrical work requiring interruption of electrical power which would adversely affect the normal operation of the other portions of the Owner's property, shall be done at time other than normal working hours. Normal working hours shall be considered eight A.M. to five P.M. Monday through Friday.

B. Schedule all work requiring interruption of electrical power two weeks prior to actual shutdown. Submit schedule in writing indicating extent of system to be de-energized, date and time when power is intended to be interrupted, and date and time power will be restored. Schedule shall be subject to the approval of the Engineer and the Representative of the Owner.

1.12 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project.

B. Verify the secondary service voltage of the buildings to be served and transmit written verification to the Engineer prior to submitting shop drawings or ordering any voltage rated materials for use in the buildings to be served.

PART 2 - BASIC MATERIALS

2.01 MATERIALS

A. All materials shall be new.

B. Furnish all materials specified herein or indicated on the drawings.

C. Materials of the same type shall be the product of one manufacturer.

D. All materials shall be UL listed and shall bear UL label. ETL listed material shall bear ETL label. ETL label shall be accepted in lieu of UL when the UL testing standards have been followed.

PART 3 - DISTRIBUTION PRODUCTS

3.01 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and suppliers recommendations, and in a manner to prevent damage to materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.

B. All material, except items specifically designed to be installed outdoors such as pad mounted transformers or stand-by generators, shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided by the Contractor. Provide temperature and/or humidity control where applicable. No material for installation, including conductors, shall be stored other than in an enclosed weathertight structure. Equipment stored other than as specified above shall be removed from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat and high humidity at all times. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.02 CLEANING AND PAINTING

A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touchup scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, motor control center, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.

B. Do not paint trim covers for flush mounted panelboards, telephone cabinets, pull boxes, junction boxes and control cabinets unless required by the Engineer, National Electrical Code or other Sections of the specifications. Remove trim covers before painting. Under no conditions shall locks, latches or exposed trim clamps be painted.

C. Unless indicated on the drawings or specified herein to the contrary, all painting shall be done under the PAINTING Section of these Specifications.

D. Where plywood backboards are used to mount equipment provided under Division 16, paint backboards with two coats of light grey semi-gloss paint under Division 16.

3.03 EXCAVATION, TRENCHING AND BACKFILLING

A. Perform all excavation to install conduits, indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Provide shoring as required by OSHA Standards. Remove and dispose of all excavated materials not to be used for backfill. Grade to prevent surface water from flowing into trenches and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is received from the Architect.

B. Grade the bottom of trenches to provide uniform bearing and support for conduits on undisturbed soil at every point along its entire length. Tamp overdepths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.

C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has a cover of not less than the adjacent ground but not greater than 2" above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.

3.04 ELECTRICAL SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE.

A. Testing

1. Refer to the individual specification sections and the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of the specifications for test requirements.
2. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the Engineer for approval.
3. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers Certifications

1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been reviewed by the manufacturer is installed in accordance with the manufacturer's recommendations and is operating in accordance with the specifications.
2. Provide manufacturers certification for the following systems:
   a. Engine Driven EPSS.

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, radios, etc.
2. Remove equipment covers (i.e. panelboard trims, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceilings shall be removed as directed for inspection of equipment installed above ceilings.
3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment and systems as directed by the Representative.

4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Engineer. Refer to the specific specification section for additional testing requirements. Representatives of the following systems are required for demonstrations:
   a. Engine Driven EPSS

END OF SECTION

DIVISION 26 – ELECTRICAL

260519 – WIRES AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of furnishing, installation and connections of the building wiring system, 600 volts and below. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. Wiring systems for communication and alarm systems are not included in this section unless specified to be included, by reference, in the respective specification sections for alarm and communication systems.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 44: Rubber - Insulated Wire and Cables
   b. No. 83: Thermoplastic - Insulated Wires
   c. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
   d. No. 486: Wire Connectors and Soldering Lugs
2. Insulated Cable Engineers Association Standards (ICEA):
   a. S-61-402: Thermoplastic Insulated Wire and Cable
3. National Electrical Manufacturer's Standards (NEMA):
   a. WC-5: Thermoplastic Insulated Wire and Cable
4. National Fire Protection Association Publication (NFPA):
   a. No. 70: National Electrical Code (NEC)
5. Federal Specifications (Fed. Spec.):
   a. J-C-30A(1) Cable and Wire Electrical (Power Fixed Installations)
   b. HH-I-595C: Insulation Type, Electrical, Pressure-Sensitive Adhesive, Plastic

B. Acceptable Manufacturers. Products produced by the following manufacturers which conform to this specification are acceptable.

1. Hydraulically applied conductor terminations:
   a. Square D
   b. Burndy

c. Ilsco
d. Scotch (3M)
e. Thomas and Betts (T&B)
f. Anderson

2. Mechanically applied (crimp) conductor terminations:
   a. Scotch (3M)
   b. Ideal
   c. Thomas and Betts (T&B)
   d. Burndy
3. Vinyl electrical insulating tape:
   a. Scotch (3M)
   b. Tomic
   c. Permacel
4. Twist-On Wire Connectors:
   a. Scotch (3M)
   b. Ideal
   c. Buchanan
5. Encapsulated insulating kits:
   a. Scotch (3M)
   b. Raychem
   c. Essex Group, Inc.
6. Portable cable fittings:
   a. Crouse Hinds
   b. Appleton
   c. T&B
7. Insulated cable:
   a. Brand-Rex Co.
   b. Cablec Corp.
   c. The Okonite Co.
   d. Pirelli Cable Corp.
   e. Senator Wire and Cable Co.
   f. Southwire Co.
   g. Alpha Wire and Cable
   h. Lapp Wire and Cable
   i. Houston Wire & Cable Co.
   j. Aetna Insulated Wire Co.
   k. American Insulated Wire Corp.
   l. Belden

C. Performance: Conductors shall be electrically continuous and free from short circuits or grounds. All open, shorted or grounded conductors and any with damaged insulation shall be removed and replaced with new material free from defects.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications.

B. All wire and cable shall be UL listed and shall bear a UL label along the conductor length at intervals not exceeding 24 inches.

C. All conductors shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer cover at intervals not exceeding 24 inches.

D. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings.

E. Insulation voltage level rating shall be 600 volts.

2.02 PRODUCT/MATERIALS DESCRIPTION

A. Conductors No. 10 AWG and smaller shall be solid copper, 90°C. type THHN, THWN or XHHW unless otherwise indicated on the drawings, required by the National Electrical Code, or specified elsewhere in Division 16. Where fixtures are used as raceway use 90°C type THHN or XHHN conductors.

B. Conductors larger than No. 10 AWG shall be stranded copper, 90°C,, type THHN/THWN, XHHW, unless otherwise indicated on the drawings, required by the National Electrical Code, or specified herein.

C. Fixture wire shall be No. 16 AWG silicone rubber insulated, stranded fixture wire, type SFF-2 (150°C), or No. 16 AWG thermoplastic, nylon jacketed stranded fixture wire, type TFFN (90°C). Color code as specified herein shall not be required for fixture wire; however, neutral conductor shall be identified distinctly from phase conductors.

D. Control conductors for use on 120 volt control wiring systems shall be No. 12 AWG stranded type THHN/THWN, unless indicated otherwise on the drawings.

E. Splices and taps (No. 10 AWG and smaller) - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C. with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.

F. Splices and taps (No. 8 and larger) - Hydraulically applied crimping sleeve or tap connector sized for the conductors or indent, split-bolt or bolt clamp-type connectors. Insulate the hydraulically applied connector with 90°C., 600 volt insulating cover provided by the connector manufacturer. Insulate the mechanically applied connectors with heat shrink insulator sleeve or plastic electrical insulating type. Insulator materials and installation shall be approved for the specific application, location, voltage and temperature and shall not have an insulation value less than the conductors being joined.

G. Electrical insulating tape shall be 600 volt, flame retardant, cold and weather resistant, minimally .85 mil thick plastic vinyl material; Scotch No. 88, Tomic No. 85, Permacel No. 295.

2.03 VFD CABLE

A. All feeders for motors controlled by variable frequency drives shall be served with cable specifically manufactured to mitigate the EMI and RFI effects on adjacent cables and/or conductors.

B. Acceptable manufacturers: Lapp Group USA, Belden and Alpha Wire.

C. Required characteristics for VFD power cable:

1. Class B stranded copper or tinned copper conductors with XLP/XLPE insulation.
2. Three bare copper ground conductors or integral with the cable.
3. Spiral or helical copper tape for 100% shield.
4. 1000V minimum rating.
5. 90°C, wet or dry installation, approved for direct burial, TC-ER approved.
6. PVC outer jacket.

PART 3 - EXECUTION

3.01 EXECUTION

A. Install all wiring in raceway system.

B. Connect all conductors. Torque each terminal connection to the manufacturers recommended torque value. A calibrated torqueing tool shall be used to insure proper torque application. Any conductors nicked or ringed while removing insulation shall be replaced.

C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. A maximum of two branch circuits are to be installed in any one conduit, on 1 phase 3 wire systems, unless specifically indicated otherwise on the drawings. No two

branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings.

D. Conductors shall be tested to be continuous and free of short circuits and grounds.

E. Identification

1. Conductors within pull boxes shall be grouped and identified with nylon tie straps with circuit identification tag.
2. Identify each control conductor at its terminal points with wrap around tape wire markers. I.D. to indicate terminal block and point designation, or other appropriate identifying indication.
3. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional identification requirements.

F. Color Code Conductors.

1. Color code all secondary service, feeder and branch circuit conductors. Control and signal system conductors need not be color coded.
2. Coding shall be as follows:
   a. 208Y/120 volt three phase four wire wye system - Phase A: Black, Phase B: Red, Phase C: Blue, Neutral: White
   b. 480Y/277 volt three phase four wire system - Phase A: Brown, Phase B: Orange, Phase C: Yellow, Neutral: Gray
   c. 240/120 volt single phase 3 wire system - Phase A: Black, Phase B: Red, and Neutral: White
3. Grounding conductors shall be green.
4. Conductors No. 6 and smaller shall have solid color compound insulation or continuous color finish. Conductors No. 4 and larger shall have colored phase tape. Colored tape shall be installed on conductors in every box, at each terminal point, cabinet, through manhole or other enclosure.

G. Maintain phase rotation established at service equipment throughout entire project.

H. Group and lace with nylon tie straps all conductors within enclosures, i.e. panels, motor controllers, motor control center, switchboard, switchgear, terminal cabinets and control cabinets.

I. Make splices in conductors only within junction boxes. Do not splice conductors in pull boxes, panelboards, safety switches, switchboard, switchgear, motor control center, wiring troughs or motor control enclosures.

J. Terminate conductors No. 10 AWG and smaller specified in Division 16 to be stranded, with crimp type lug or stud. Direct termination of stranded conductors without crimp terminator to terminal screws, lugs, or other points is not permitted even if terminal is rated for stranded conductors. Crimp terminal shall be the configuration type suitable for terminal point. Crimp lugs shall be applied in strict accordance with the manufacturer’s written requirements.

K. Make connections between fixture junction box and fixture with fixture wire.

L. Control, communications or signal conductors shall be installed in separate raceway systems from branch circuit or feeder raceway, unless indicated otherwise on the drawings.

M. Splices in conductors installed below grade are not permitted.

END OF SECTION

DIVISION 26 – ELECTRICAL

260526 – SECONDARY GROUNDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of furnishing, installation and connections of the building secondary grounding systems. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. The building electrical system shall be a 3 phase, 4 wire grounded wye system supplemented with equipment grounding system. Equipment grounding system shall be established with equipment grounding conductors; the use of metallic raceways for equipment grounding is not acceptable.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 44: Rubber - Insulated Wire and Cables
   b. No. 83: Thermoplastic - Insulated Wires
   c. No. 467: Electrical Grounding and Bonding Equipment
   d. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
   e. No. 486: Wire Connectors and Soldering Lugs
2. National Electrical Manufacturer's Standards (NEMA):
   a. WC-5: Thermoplastic Insulated Wire and Cable
   b. WC-7: Cross-Linked-Thermosetting Polyethylene Insulated Wire and Cable
3. National Fire Protection Association Publication (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers. Products produced by the following manufacturer which conform to this specification are acceptable.

1. Hydraulically applied conductor terminations:
   a. Square D
   b. Burndy
   c. Ilsco

d. Scotch (3M)
e. Thomas and Betts (T & B)
f. Anderson

2. Mechanically applied (crimp) conductor terminations:
   a. Scotch (3M)
   b. Ideal
   c. Thomas and Betts (T & B)
   d. Burndy
3. Exothermic connections:
   a. Cadweld

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications. All materials shall be new.

B. All materials shall be UL listed and bear a UL label.

C. Refer to the specific specification section for the description and requirements of materials mentioned herein for installation.

2.02 GROUNDING CONDUCTORS

A. Grounding electrode conductor shall be bare or green insulated copper conductor sized as indicated on the drawings.

B. Equipment grounding conductors shall be green insulated type THW, THWN, or XHHN conductors sized as indicated on the drawings. Where size is not indicated on the drawings, conductor size shall be determined from the National Electrical Code table on sizes of equipment grounding conductors.

C. Bonding jumpers shall be flexible copper bonding jumpers sized in accordance with the National Electrical Code tables for grounding electrode conductors.

2.03 TRANSFORMERS, MOTOR CONTROLLERS, AND DISCONNECT SWITCHES

A. Provide a conductor termination grounding lug bonded to the enclosure of each equipment item.

2.04 DEVICES

A. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame.

2.05 GROUND RODS

A. Ground rods shall be 3/4" x 10'-0" copper clad steel.

B. Sectional ground rods shall be hot dip galvanized 5/8" x 10' sections with an internal stainless steel splined coupling pin.

2.06 OTHER MATERIALS

A. Ground bus shall be solid copper, 1/4" thick x 2" x 24", tapped and drilled for conductor termination lug connections.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ground all non-current carrying parts of the electrical system, i.e., wireways, equipment enclosures and frames, junction and outlet boxes, machine frames and other conductive items in close proximity with electrical circuits, to provide a low impedance path for potential grounded faults.

B. Service entrance and separately derived electrical systems, grounding electrode system.

1. The neutral conductor of the electrical service serving the premises wiring system shall be grounded to the ground bus bar in the service equipment which shall be grounded to the cold water system, the ground rod system, and other grounding electrodes specified herein or indicated on the drawings. Grounding electrode conductors shall be installed in rigid, non-metallic conduit to point of ground connection, unless subject to physical damage in which case they shall be installed in galvanized rigid steel. Where metallic conduit is permitted, bond conduit at both ends to grounding electrode conductor with a UL bonding bushing.
2. Make connection to main water line entering the building. Make connections ahead of any valve or fittings whose removal may interrupt ground continuity. Install a bonding jumper of the same size as the grounding conductor around the water meter.
3. Bond together the following systems to form the grounding electrode system. All system connections shall be made as close as possible to the service entrance equipment and each connected at the service entrance equipment ground bus. Do not connect electrode systems together except at ground bus.
   a. Cold water piping system
   b. Ground rod system
   c. Main rebar in a foundation footing, for a concrete structure

4. Ground the neutral of all dry type transformers to building steel which shall serve as the grounding electrode for the separately derived system. In reinforced concrete structures building steel shall be considered to be reinforcing steel of vertical columns. Make connection to building steel with an exothermic weld in a location in unfinished space where the connection will not be subject to physical abuse.
5. Ground the neutral and frame of the emergency generator to building steel and the ground rod system, which shall serve as the grounding electrode for the separately derived system. In reinforced concrete structures building steel shall be considered to be reinforcing steel of vertical columns. Make connection to building steel with an exothermic weld in a location in unfinished space where the connection will not be subject to physical abuse.
6. Grounding electrode connections to structural steel, reinforcing bars, ground rods, or where indicated on the drawings shall be with chemical exothermic weld connection devices recommended for the particular connection type. Connections to piping shall be with UL listed mechanical ground clamps.
7. Where more than one service serves a building or interconnected buildings, connect each service equipment ground bus together with a #4/0 copper conductor in PVC conduit.
8. Bonding shall be in accordance with the National Electrical Code.
9. Install ground rods where indicated on the drawings with the top of the ground rods 12" below finished grade.

C. Equipment Grounding Conductor

1. Grounding conductors for branch circuits are not shown on the drawings; however, grounding conductors shall be provided in all branch circuit raceways and cables. Grounding conductors shall be the same AWG size as branch circuit conductors.
2. Grounding conductors for feeders are typically indicated on the drawings and the raceway is sized to accommodate grounding conductor shown. Where grounding conductor size is not indicated on the drawings, conductor shall be in accordance with the equipment grounding conductor table of the National Electrical Code.
3. A grounding conductor shall be installed in all flexible conduit installations. For branch circuits, grounding conductor shall be sized to match branch circuit conductors.
4. A feeder serving several panelboards shall have a continuous grounding conductor which shall be connected to each related cabinet grounding bar.
5. The equipment grounding conductor shall be attached to equipment with bolt or sheet metal screw used for no other purpose. Where grounding conductor is stranded, attachment shall be made with lug attached to grounding conductor with crimping tool.

6. Ground all motors by drilling and tapping the bottom of the motor junction box and attaching the equipment grounding conductor to the box with a round head bolt used for no other purpose. Conductor attachment shall be through the use of a lug attached to conductor with crimping tool.
7. Equipment grounding conductors shall terminate on panelboard, switchboard, or motor control center grounding bus only. Do not terminate on neutral bus. Provide a single terminals lug for each conductor. Conductor shall terminate in the same section as the phase conductors originate. Do not terminate neutral conductors on the ground bus.

D. Other Grounding Requirements

1. Each telephone backboard shall be provided with a No. 6 grounding conductor. When backboard is located in vicinity of electrical service equipment, the "point of grounding" of this conductor shall be the main cold water service with connections made ahead of any valves or joints. Remote backboards shall use building steel as "point of grounding". Terminate conductor by stapling to backboard.
2. At each building expansion joint flexible copper bonding jumpers shall be attached to building structure by exothermic weld process. Install bonding jumpers in concealed locations that will not subject connections or jumpers to physical abuse. Install 100' on centers across expansion joints.
3. Lighting fixtures shall be grounded with a green insulated ground wire secured to the fixture with a UL listed bond lug, screw, or clip specifically made for such use.

3.02 TESTING

A. Upon completion of the ground rod installation, the Contractor shall test the installation in accordance with the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification. Grounding resistance reading shall be taken before connection is made to the building cold water piping system. Ground resistance readings shall not be taken within forty-eight hours of rainfall. Results of ground resistance readings shall be forwarded, in writing, immediately to the Architect.

END OF SECTION

DIVISION 26 – ELECTRICAL

260529 – SUPPORTING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Extent of supports, anchors, sleeves and seals is indicated by drawings and schedules and/or specified in other Division - 16 sections.

B. Types of supports, anchors, sleeves and seals specified in this section include the following:

1. Clevis hangers.
2. Riser clamps.
3. C-clamps.
4. I-beam clamps.
5. One-hole conduit straps.
6. Two-hole conduit straps.
7. Round steel rods.
8. Expansion anchors.
9. Toggle bolts.
10. Wall and floor seals.

C. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment are specified as part of that equipment assembly in other Division - 16 sections.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

C. UL Compliance: Provide electrical components which are UL-listed and labeled.

D. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.

PART 2 - PRODUCTS

2.01 MANUFACTURED SUPPORTING DEVICES

A. General: Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.

B. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" diameter hole for round steel rod; approximately 54 lbs. per 100 units.
2. Reducing Couplings: Steel rod reducing coupling, 1/2" x 5/8"; black steel; approximately 16 lbs. per 100 units.
3. C-Clamps: Black malleable iron; 1/2" rod size; approximately 70 lbs. per 100 units.
4. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2"; approximately 52 lbs. per 100 units.
5. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 lbs. per 100 units.
6. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
7. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 lbs. per 100 units.
8. Round Steel Rod: Black steel; 1/2" diameter; approximately 67 lbs. per 100 feet.
9. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 lbs. per 100 units.

C. Anchors: Provide anchors of types, sizes and materials indicated, with the following construction features:

1. Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 lbs. per 100 units.
2. Expansion sleeve anchors by Hilti or Phillips Redhead: 1/2"; approximately 38 lbs. per 100 units.

3. Manufacturers: Subject to compliance with requirements, provide anchors of one of the following:
   a. Ackerman Johnson Fastening Systems Inc.
   b. Hilti
   c. Ideal Industries, Inc.
   d. Joslyn Mfg and Supply Company
   e. McGraw Edison Company
   f. Phillips Redhead
   g. Rawlplug Company Inc.

D. Sleeves and Seals: Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:

1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

E. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

F. U-Channel Strut Systems:

1. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" diameter holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel. Provide 304 stainless steel U-channel for all exterior installations.
   a. Fixture hangers.
   b. Channel hangers.
   c. End caps.
   d. Beam clamps.
   e. Wiring studs.
   f. Thinwall conduit clamps.
   g. Rigid conduit clamps.
   h. Conduit hangers.
   i. U-bolts.
2. Manufacturers: Subject to compliance with requirements, provide channel systems of one of the following:
   a. Allied Tube and Conduit Corporation.
   b. B-Line Systems, Inc.
   c. Elcen Metal Products Company.
   d. Greenfield Mfg Company, Inc.
   e. Midland-Ross Corporation.

f. OZ/Gedney Div; General Signal Corporation.
g. Power-Strut Div; Van Huffel Tube Corporation.
h. Unistrut Div; GTE Products Corporation.

2.02 FABRICATED SUPPORTING DEVICES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal: 3" and smaller, 20-gage; 4" to 6", 16-gage; over 6", 14" gage.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Iron Pipe: Fabricate from cast-iron or ductile-iron pipe.
4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

B. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.01 INSTALLATION OF SUPPORTING DEVICES

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Remove burrs from ends of pipe sleeves.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533 – RACEWAYS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section covers the complete interior and exterior raceway system.

B. Definition: The term conduit, as used in this Specification, shall mean any or all of the raceway types specified.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   No. 1 Flexible Metal Electrical Conduit
   No. 6 Rigid Galvanized Conduit
   No. 467 Electrical Grounding and Bonding
   No. 651 Rigid Nonmetallic Electrical Conduit
   No. 797 Electrical Metallic Tubing
   No. 1242 Intermediate Metal Conduit
2. American National Standards Institute (ANSI):
   C-80.1 Rigid Galvanized Conduit.
   C-80.3 Electrical Metallic Tubing.
3. National Fire Protection Association (NFPA):
   No. 70 National Electrical Code (NEC).
4. Federal Specifications (Fed Spec):
   a. WW-C-540A: Conduit, Metal, Rigid (Electrical Aluminum).
   b. WW-C-581E: Conduit, Metal, Rigid; And Couplings, Elbow and
   c. Nipple, Electrical Conduit: Zinc Coated.
   d. W-C-1094A: Conduit and Conduit Fittings Plastic, Rigid.

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Metallic Conduit Fittings:
   a. Appleton
   b. Carlon
   c. Crouse Hinds
   d. Killark
   e. O-Z/Gedney
   f. RACO
   g. Thomas and Betts
2. Support Channel:
   a. Kindorf
   b. Powers
   c. Unistrut
3. Non-Metallic Conduit and Fittings:
   a. Carlon
   b. Certainteed
   c. Thomas and Betts

C. Coordination

1. Coordinate conduit installation with electrical equipment furnished.
2. Coordinate conduit installation with contract documents and other contractors. Adjust installation to eliminate conflicts. Review all shop drawings submitted under this and other sections to insure coordination with all equipment requiring electrical service and to avoid conflict interferences. Coordinate installation sequence with other contractors to avoid conflicts including equipment access and provide the fastest overall installation schedule.

1.04 STORAGE AND HANDLING

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section of the specifications for storage and handling requirements.

B. Non-metallic conduits stored on site prior to installation shall be stored on a surface off of the ground and shall be protected from the direct rays of the sun and from debris.

C. Damaged, oxidized, warped, improperly stored material or material with excessive amounts of foreign debris will be removed from the project and replaced with new materials.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All conduit and fittings shall be listed and bear a label by Underwriters' Laboratories (UL) for use as raceway system for electrical conductors.

C. Raceway is required for all wiring, unless specifically indicated or specified otherwise.

D. Size: The minimum size of conduit shall be 3/4". The size of all conduits shall be in accordance with the NEC, but, not less than indicated on the drawings.

2.02 EMT CONDUIT FITTINGS

A. Electrical Metallic Tubing (EMT) couplings and connectors shall be steel "concretetight" type. Malleable iron, die cast or pressure cast fittings are not permitted. Fittings 2.0" and smaller shall be gland and ring compression type. Connectors for conduits 2.5" and larger shall be set screw type with two (2) screws each or compression type. Couplings for conduits 2.5" and larger shall be set screw type with four (4) screws each or compression type. All connectors shall be insulated throat type. All set screw connectors encased in walls or floor shall be taped at all joints.

2.03 RIGID AND IMC CONDUIT FITTINGS

A. Fittings for rigid steel and IMC shall be standard threaded couplings, threaded hubs and elbows. All materials shall be steel or malleable iron only. Set screw or non-thread fittings are not permitted. Bushings shall be metallic insulating type consisting of insulating insert molded or locked into the metallic body of the fittings. Erickson-type couplings may be used to complete a conduit run.

2.04 NON-METALLIC CONDUIT AND FITTINGS

A. Non-metallic conduit shall be schedule 80 PVC.

B. Non-metallic conduit fittings shall be of the same material as the conduit furnished and be the product of the same manufacturer.

C. Glue for all non-metallic conduit and fittings shall be provided as required by the manufacturer of the conduit being used.

2.05 CONDUIT SUPPORTS

A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.

B. Conduit straps shall be single hole cast metal type or two hole galvanized metal type.

C. Conduit support channels shall be 1.5" x 1.5" x 14 gauge galvanized (or with equivalent treatment) channel. Channel suspension shall be 3/8" threaded steel rods. Use swivel type connector to attach suspension rods to structure. Spring steel clips are not acceptable. Wire or chain is not acceptable for conduit hangers. Stainless steel channels, fasteners and conduit straps shall be used on all exterior installations.

D. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose, sized appropriately for the conduit type and diameter, and have pre-assembled closure bolt and nut and provisions for receiving threaded hanger rod. Support with 1/4" threaded steel rod for individual conduits 1.5" and smaller and 3/8" rod for individual conduits 2.0" and larger.

E. Refer to SUPPORTING DEVICES section of these specifications for additional material requirements.

2.06 FLEXIBLE CONDUIT AND FITTINGS

A. Flexible conduit shall be steel metallic type. Where specified herein, indicated on the drawings, or when used in damp or wet locations, as classified by the National Electrical Code, flexible conduit shall be liquid tight.

B. All flexible conduit shall be classified as suitable for system grounding. All flexible (liquid tight) conduits shall be UL listed as sunlight (UV) resistant.

C. Connectors for flexible conduit shall be steel insulated throat type rated as suitable for system ground continuity. Connectors for liquid tight flexible conduit shall be screw-in ground cone type.

D. Flexible conduit shall not be less than 3/4" trade size and in no case shall flexible conduit size be less than permitted by the National Electrical Code for the number and size of conductors to be installed herein.

2.07 MISCELLANEOUS CONDUIT FITTINGS AND ACCESSORIES

A. Vinyl all weather electrical tape for corrosion protection shall be Scotch Temflex

B. Expansion and deflection couplings shall be in accordance with UL 467 and UL 514. They shall accommodate 3/4" deflection, expansion, or contraction in any direction and shall allow 30 degree angular deflections. Couplings shall contain an internal flexible metal braid to maintain raceway system ground continuity.

C. Fire and smoke stop materials shall be rock wool fiber, silicone foam, or silicone sealant, UL rated to maintain the fire floor or fire wall partition rating.

2.08 RIGID ALUMINUM CONDUIT FITTINGS

A. Rigid aluminum conduit fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be compatible with aluminum conduit of malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper. Threaded hubs shall be as specified for rigid steel and IMC conduit. Set screw fittings or no-thread fittings are not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Conceal all conduits, except in unfinished spaces such as equipment rooms or where indicated by symbol on the drawings.
2. Leave all empty conduits with a 200 pound test nylon cord pull line.
3. Install as complete raceway runs prior to installation of cables or wires.
4. Flattened, dented, burned, or deformed conduits are not permitted and shall be removed and replaced.
5. Secure rigid conduit i.e., rigid galvanized conduit, rigid aluminum conduit and intermediate metal conduit, to sheet metal enclosures with threaded hubs. Secure EMT to sheet metal enclosures with insulated throat connectors with lock nut.
6. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on metal studs. Nails are not acceptable.
7. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry is complete. Protect conduit stub-ups during construction from damage; any damaged conduits shall not be used.
8. Seal all conduits originating from outside building from below grade and all conduits entering exterior mounted electrical equipment with insulating electrical putty to prevent entrance of moisture. Spray foam is not acceptable.
9. Install conduit with wiring, including homeruns as indicated on the drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.

10. Use flexible conduit for connection to vibrating equipment and rotating machinery and for connection from junction box to flush mounted lighting fixtures only.
11. Separate raceway systems are to be installed for power systems and for control, signal and communications systems. Do not install control, signal or communications cables in the same raceways as branch circuit or feeder cables, unless indicated otherwise on the drawings.
12. Provide expansion fitting in all conduits where length of run exceeds 200 feet or where conduits pass building expansion joints.

B. Uses Permitted

1. Conduits installed within concrete floor slabs which are in direct contact with grade or other material shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Conduits which penetrate the building roof shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Conduits installed within concrete floor slabs which are above grade shall be galvanized rigid steel (GRS), intermediate metal conduit (IMC), or schedule 80 Heavy Wall PVC. Where transition is made from raceway in slab to any type of raceway out of slab, make transition with rigid galvanized elbow. For corrosion protection, where elbow penetrates surface, apply two coats of Scotchrap pipe primer and two overlapping layers of Scotchrap Temflex tape, for 6" above and below concrete surface.
2. Conduits installed in direct contact with earth shall be schedule 80, heavy wall PVC.
3. Service entrance conduits in direct contact with earth shall be galvanized steel. Other conduit in direct contact with earth shall be schedule 80, heavy wall PVC.
4. All other conduit, unless excluded herein, not permitted in accordance with the National Electrical Code, or otherwise indicated on the drawings, shall be electrical metallic tubing (EMT).
5. Conduit types shall not be mixed indiscriminately with other types in the same run, unless specified herein or required by the NEC.
6. Use flexible conduit for connections to motors, dry type transformers and unit heaters.
    a. Flexible conduit used for connection of motors, dry type transformers, electric duct heaters, unit heaters, busway tap devices and voltage regulators shall not exceed 18" in length.
    b. Maintain ground continuity through flexible conduit with green equipment grounding conductor; do not use flexible conduit for ground continuity.
    c. Liquid tight conduit shall be used to connect equipment in mechanical equipment rooms and exterior installations.
7. Service entrance and feeder conduits installed exposed or concealed in walls or above ceilings shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Service entrance conduits shall be installed "outside" of the building as defined by the NEC. Provide concrete encasement where required.

8. No conduit requiring cutting of cross-webs of concrete masonry units is permitted. Conduit shall be threaded through cells or concrete masonry units lowered around conduit. Neither horizontal joint reinforcement nor bond beam reinforcement shall be cut for conduit installation. Conduits shalal not be run horizontally in walls.
9. Rigid aluminum conduit may be used for all trade sizes 3.0" and larger for conduits not installed in concrete slabs, not installed in direct contact with earth, not installed in hazardous locations as defined by Article 500 of the National Electrical Code and not installed in areas exposed to excessive moisture.
10. All conduits installed exposed from the finished floor to a minimum height of 10 ft. above the floor shall be galvanized rigid steel (GRS) or intermediate metallic conduit (IMC).
11. Where hazardous locations, as classified by the National Electrical Code, exist, all conduits and fittings and the installation of these materials shall comply with Article 500 of the National Electrical Code.

C. Below Grade Raceway Installations

1. Direct Burial Conduit
   a. Install top of conduits 24" minimum below finished grade. Maximum depth shall be 36".
   b. Install top of conduits 6" minimum below bottom of building slabs.
   c. Install top of conduits 30" minimum below grade, below roads and any other paved surfaces.
   d. Where transition is made from below grade PVC installation to a metallic conduit system above grade or slab, make transition with rigid galvanized elbow and extend through slab or above grade with galvanized rigid steel conduit. For corrosion protection, where the elbow penetrates surface, apply two coats of Scotchrap pipe primer and two overlapping layers of Scotchrap Temflex tape, for 6" above and below concrete surface.
   e. For excavation and backfilling, refer to earthwork specification section.
   f. Conduit shall be run following the most direct route between points.

D. Raceway Installations Within Concrete

1. Conduit shall be run following the most direct route between points.
2. Conduit shall not be installed in concrete which is less than 3" thick or where the outside diameter is larger than 1/3 of the slab thickness.
3. Conduits installed in concrete slabs shall be buried in the concrete slab. Wire low conduits to upper side of the bottom reinforcing steel, and upper conduits to the lower side of the top reinforcing steel. Separate parallel runs of conduits within slab by at least 1".
4. Conduits shall not be installed within shear walls unless specifically indicated on the drawings. Conduits shall not be run directly below and parallel with load bearing walls

5. Protect each metallic conduit installed in concrete slab or conduits 1.5" and smaller passing through a concrete slab against corrosion where conduit enters and leaves concrete by wrapping conduit with vinyl all-weather electrical tape.
6. The maximum projection of conduit stub-up and bushing above slab shall be 3" in equipment rooms.
7. Protect all conduits entering and leaving concrete floor slabs from physical damage during construction.

E. Concealed (Above Ceilings and in Walls) and Exposed Raceway Installation

1. Conduit shall be run parallel or at right angles to existing walls, ceilings, and structural members.
2. Support branch circuit conduits at intervals not exceeding 10 ft. and within three feet of each outlet, junction box, cabinet or fitting. Attach individual branch circuit conduits to structural steel members with beam conduit clamps and to non-metallic structural members with one hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hangar rod and conduit clamp assembly. Multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.
3. Attach feeder conduits larger than 1" trade diameter to or from structure on intervals not exceeding 12 ft. with conduit beam clamps, one hole conduit straps or trapeze type support in accordance with support systems described for branch circuit conduits.
4. Where conduits must pass through structural members, obtain approval of Engineer with respect to location and size of hole prior to drilling.
5. Install conduit sleeves in slabs where conduits 2.0" and larger pass through. Sleeves shall extent 1" minimum above finished slab. Seal all spare sleeves and between conduits and sleeves to make watertight.
6. Seal all conduit penetrations, sleeves and conduits penetrating chemical room walls and ceilings to prevent the migration of hazardous gases.
7. Conduits rigidly secured to building construction on opposite sides of a building expansion joint shall be provided with an expansion and deflection coupling. In lieu of an expansion coupling, conduits 2-1/2" and smaller may be provided with junction boxes on both sides of the expansion joint connected by 15" of slack flexible conduit with bonding jumper.

3.02 ADJUSTMENT, CLEANING AND PROTECTION

A. Clean: Upon completion, clean all installed materials of paint, dirt, and construction debris. All conduit systems shall be cleaned of water and debris prior to the installation of any conductors.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533.01 – BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of the installation of outlet boxes, pull boxes, and junction boxes throughout the wiring system including box supports.

B. Definition: Box, as used in this specification, includes all outlet, device, junction, and pull boxes. Feeder shall mean all conductor circuits larger than #8 AWG, including service entrance conductors, and all wiring above 600V.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 50: Electrical Cabinets and Boxes
   b. No. 467: Electrical Grounding and Bonding Equipment
   c. No. 514: Electrical Outlet Boxes and Fittings
2. National Fire Protection Association (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Coordination: Review architectural drawings for areas where outlets occur within specific architectural or structural features and install outlets as shown on architectural drawings; or if not shown, accurately center and align boxes within the architectural features or detail.

C. Acceptable Manufacturers:

1. Exterior junction or pull boxes:
   a. Quaztite: Type PG
   b. Old Castle Synertech
   c. Penecel

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All boxes shall be UL listed and labeled.

C. Boxes shall be galvanized steel sheet metal, unless rustproof cast metal is specified or required by the NEC, or unless otherwise specified or indicated on the drawings.

2.02 OUTLET AND DEVICE BOXES

A. Outlet boxes for surface mounted and pendant mounted lighting fixtures shall be 4" octagon boxes, 1-1/2" deep.

B. Outlet boxes for flush mounted lighting fixtures shall be 4" square boxes 1-1/2" deep, with blank cover, installed adjacent to fixture. Connection to fixture shall be with flexible conduit and fixture wire.

C. Outlet boxes for switches, receptacles and wall mounted junction boxes shall be 4" square boxes, 1-1/2" deep with square edge tile type cover. Where only one conduit enters box, 3-1/2" deep single gang switch box may be used. Outlet boxes for GFI receptacles shall be 2-3/4" deep.

D. Outlet boxes for switches and receptacles in exposed wiring system shall be cast FS boxes with matching device plate. Device plates for exterior installations shall be spring loaded hinged covers. Use FD box for GFI receptacle.

E. Outlet boxes for individual switches, and receptacles flush mounted in exposed concrete block shall be single gang masonry boxes 3-1/2" deep.

F. Where special purpose device specified requires larger outlet box than specified herein, provide outlet box suitable for specific device. These outlet boxes shall be of the same type as specified herein for the installation required.

G. Outlet boxes installed in poured concrete or cast in place shall be concrete-tight type. The box depth shall allow 2" minimum of concrete cover.

2.03 JUNCTION AND PULL BOXES

A. Dimensions of pull boxes and junction boxes shall not be less than those dimensions required by the National Electrical Code for the number, size and position of conductors entering the box. Extension rings shall not be permitted on a box to increase the volume.

B. Pull boxes installed in finished spaces shall be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match panel trim for flush mounted electrical panelboard.

C. Pull boxes required for horizontal feeders containing more than one feeder shall be provided with reinforced flange and removable 12 gauge 1-1/2" x 1-1/2" galvanized channel for support of conductors. Wood supports within pull boxes are not acceptable.

D. Provide box covers for all junction and pull boxes.

2.04 EXTERIOR JUNCTION OR PULL BOXES, FLUSH WITH GRADE

A. Junction or pull box to be mounted flush with grade shall be as indicated on the drawings. Provide polymer concrete, tier 22 traffic rated sized in accordance with the National Electrical Code minimum requirements. Covers shall be polymer concrete, tier 22 traffic rated with identifying system (i.e. Electrical) in cover secured to box with stainless steel bolts. Conduit entry shall be by field drilled openings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All boxes shall be completely accessible and as required by the NEC. Provide access panels in any non-accessible spaces to allow access to boxes installed. Crawling above ceilings to access boxes is not acceptable.

B. Provide an outlet box for each lighting fixture and for each device. Boxes shall not be smaller than indicated in this section of the specifications and shall be larger if required by Article 314 of the National Electrical Code for the number and size of conductors installed. Where lighting fixtures are installed in continuous rows, only one outlet box shall be required.

C. Outlet boxes for flush mounted lighting fixtures shall be accessible. Where fixture installation is in nonaccessible ceiling, outlet box shall be accessible when fixture is removed.

D. Set outlet boxes for flush mounted devices to within 1/8" of finished wall. Spacers or shims between box and device are not acceptable. Modification of boxes or use of extensioin rings to provide for 1/8” of finished wall is not acceptable.

E. Where low voltage device is to be installed in common outlet boxes with line voltage device, provide metal barrier within outlet box to establish two separate compartments.

F. Where drawings indicate ganged installations of switches controlling 277 volt lighting circuits of opposite phase, separate switches with permanently installed nonmetallic barrier. Where space available for horizontal ganged installation is not adequate, install switches vertically to maintain required clearances between energized terminals.

G. Support every box from structure:

1. Secure to wood with wood screws.
2. Secure to hollow masonry with toggle bolts.
3. Secure to metal with sheet metal screws, machine bolts, or clamps.
4. Anchors for solid masonry and concrete shall be self drilling expansion shields, insert expansion shields, or lead shields with machine bolts. Power actuated pin studs may be used in concrete.
5. Secure outlet boxes to metal studs with spring steel clamp which wraps around entire face of stud and digs into both sides of stud. Clamp shall be screwed into stud.
6. Where box is suspended below structure, support from structure with threaded steel rod. Secure rod directly to outlet boxes with double nuts. For pull boxes larger than 18" x 18" x 6", construct 1-1/2" x 1-1/2" x 14 gauge metal channel frame. Connect frame to box by bolting and secure frame to threaded rod at each corner.
7. Hub type cast boxes need not be directly attached to structure if rigid conduit is used and supported in conformance with the NEC.

H. Support outlet boxes for support of surface mounted incandescent lighting fixtures by light weight channel spanning between and attached to main ceiling support member. Attach channel to ceiling support members with galvanized tie wire or nylon tie straps.

I. Do not use outlet boxes for support of fluorescent fixtures; boxes shall be used only as junction boxes.

J. Remove only knockouts as required and plug all unused openings. Use threaded plugs for cast boxes and snap-in metal plugs for sheet metal boxes.

K. Outlet boxes in the same wall shall not be mounted back-to-back. Offset 6" minimum.

L. Install pull boxes only in unfinished spaces or concealed above ceilings, except when indicated on the drawings or approved by the Engineer.

M. Install pull boxes when any of the following conditions apply:

1. Where indicated on the drawings.
2. Where conduit run exceeds 200 ft. from box to box or box to terminal.
3. Where conduit contains more than 4-90 degree bends or the equivalent offsets.

4. To facilitate conductor installation or to insure that the manufacturer's maximum pulling tension is not exceeded.
5. As described in the RACEWAYS section of the specifications for crossing expansion joints.

N. Do not splice conductors in pull boxes. Splices are not permitted in pull boxes except when approved in writing by the Engineer or where shown on the drawings. Where splices are permitted, make splices with splicing sleeves attached to conductors with hydraulic crimping tool. Split bolt connectors are not acceptable for splices within pull boxes.

O. Where a pull box is required, one shall be installed for each individual branch circuit conduit or each feeder. It shall contain only the feeder conductors or those conductors in the conduit. A combined pull box for multiple branch conduits or feeders is not permitted, unless approved by the Engineer or indicated on the drawings. Where permitted for multiple circuits within pull box:

1. Circuit conductors and feeders shall be individually laced with nylon tie straps of the type with enlarged tab to permit identification of each circuit and feeder within pull box. Identify each with respect to load served.
2. Feeder circuits shall be wrapped, in accordance with manufacturer's recommendations, with arc-proof and fire proof tape.

P. Box covers shall be in place and secured to box.

Q. Identification

1. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional requirements.

R. Exterior pull or junction boxes

1. Exterior pull or junction boxes shall be mounted flush with the grade, unless specified elsewhere or indicated to be aboveground on the drawings.
2. Flush mounted boxes shall be surrounded on all sides and bottom with 6" minimum of concrete. Top of concrete shall be flush with grade.
3. Seal conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
4. Taps and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean all work of dirt, paint and construction debris.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533.02 – ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

B. Applications of electrical power connections specified in this section include the following:

1. To resistive heaters.
2. From electrical source to motor starters.
3. From motor starters to motors.
4. To lighting fixtures.
5. To transformers and similar current current adjustment features of equipment.

C. Electrical connections for equipment, not furnished as integral part of equipment, are specified in Division - 15 and other Division - 16 sections, and are work of this section.

1. Division 1 - GENERAL REQUIREMENTS
2. Division 11 - EQUIPMENT
3. Division 13 - SPECIAL CONSTRUCTION

D. Motor starters and controllers, not furnished as integral part of equipment, are specified in applicable Division - 16 sections, and are work of this section.

E. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division - 16 sections, and are work of this section.

F. Raceways and wires/cables required for connecting motors and other electrical units of equipment are specified in applicable Division 16 sections, and are work of this section.

G. Electrical identification for wire/cable conductors is specified in Division - 16 section, ELECTRICAL IDENTIFICATION, and is work of this section.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches. NEC Article 110-14, "ELECTRICAL CONNECTIONS" applies to above.

B. IEEE Compliance: Comply with Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.

C. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

1. ANSI/NEMA CC3: "Connectors for use between aluminum or aluminum-copper overhead conductors."
2. ANSI/EIA RS-364-21A: "Insulation Resistance Test"
3. STD SG-14: "Unplated split-bolt and Vice-Type Electrical Connectors for Copper Conductors".

D. UL Compliance: Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL-listed and labeled.

1. STD. NO. 486A; Wire Connectors and Soldering Lugs for Use with Copper Conductors.
2. STD. No. 486B; Wire Connectors for Use with Aluminum Conductors.
3. STD. NO. 486C; Splicing Wire Connectors.
4. STD. NO. 486D; Insulated Wire Connectors for Use With Underground Conductors.

E. ETL Compliance: Provide electrical connection products and materials which are ETL-listed and labeled.

F. ASTM Compliance: Comply with Standard B539 "Standard Methods for Measuring Contact Resistance of Electrical Connections (Static Contacts)."

G. Federal Specifications:

1. J-C-30 Electrical Cable and Wire (Power, Fixed Installation).
2. J-C-145 Electrical Power Cable and Electrical Wire (Weather Resistant).
3. W-C-596 1 through 212-Series. (Connectors).
4. W-S-610 Splice Conductor
5. HH-I-553 Electrical Insulation Tape (Rubber, Natural, and Synthetic).
6. HH-I-595 Electrical Plastic Insulation Tape, Pressure Sensitive Adhesive.

1.04 SUBMITTALS:

A. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver electrical connection products wrapped in proper factory-fabricated type containers.

B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.

C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of product):
1. AMP Incorporated.
2. Appleton Electric Company.
3. Arrow-Hart Div, Crouse-Hinds Company.
4. Bishop Div, General Signal Corporation.
5. Burndy Corporation.
6. General Electric Company.
7. Gould, Inc.
8. Harvey Hubbell Inc.
9. Ideal Industries, Inc.
10. Reliable Electric Company.
11. Square D Company
12. Thomas and Betts Corporation.

2.02 MATERIALS AND COMPONENTS

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings:

1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Division - 16 BASIC ELECTRICAL MATERIALS and RACEWAYS section, and in accordance with the following listing of metal conduit, tubing and fittings:
   a. Rigid aluminum conduit.
   b. Rigid steel conduit.
   c. Rigid metal conduit fittings.
   d. Electrical metallic tubing.
   e. EMT fittings.
   f. Flexible metal conduit.
   g. Flexible metal conduit fittings.
   h. Liquid-tight flexible metal conduit.
   i. Liquid-tight flexible metal conduit fittings.

C. Wires, Cables, and Connectors:

1. Provide wires, cables, and connectors complying with Division - 16 basic electrical materials and methods section "WIRES AND CABLES".
2. Wires/Cables: Unless otherwise indicated, provided wires/cables (conductors) for electrical connections which match, including sizes and ratings, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals which are recommended by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Cover splices with electrical insulating material equivalent, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

E. Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL 486A.

H. Provide PVC conduit and fittings as indicated for highly corrosive atmospheres.

I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.

J. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subject to one or more of the following conditions:

1. Exterior location.
2. Moist or humid atmosphere where condensate can be expected to accumulate.
3. Corrosive atmosphere.
4. Water spray.
5. Dripping oil, grease, or water.

K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division - 16 section ELECTRICAL IDENTIFICATION. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION

DIVISION 26 – ELECTRICAL

260553 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Extent of electrical identification work is as outlined by this specification.

B. Types of electrical identification work specified in this section include the following:

1. Buried cable warnings.
2. Electrical power, control and communication conductors.
3. Operational instructions and warnings.
4. Danger signs.
5. Equipment/system identification signs.

C. Refer to Division 1 General Requirements section IDENTIFICATION SYSTEMS, for equipment and system nameplates, and performance data; not work of this section.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

B. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

C. ANSI Compliance: Comply with applicable requirements of ANSI Std A13.1, "Scheme for the Identification of Piping Systems".

D. NEMA Compliance: Comply with applicable requirements of NEMA Std No's WC-1 and WC-2 pertaining to identification of power and control conductors.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):

1. Almetek
2. Brady, W.H. Company
3. Calpico Inc.
4. Cole-Flex Corporation
5. Direct Safety Company
6. George-Ingraham Corporation
7. Griffolyn Company
8. Ideal Industries, Inc.
9. LEM Products, Inc.
10. Markal Company
11. National Band and Tag Company
12. Panduit Corporation
13. Seton Name Plate Company
14. Tesa Corporation

2.02 ELECTRICAL IDENTIFICATION MATERIALS

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Color-Coded Plastic Tape:

1. Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2" wide.
   a. Colors: Unless otherwise indicated or required by governing regulations, provide orange tape.

C. Underground-Type Plastic Line Marker:

1. Manufacturer's standard permanent, detectable, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

D. Cable/Conductor Identification Bands:

1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

E. Plasticized Tags:

1. Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

F. Self-Adhesive Plastic Signs:

1. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.
2. Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.

G. Baked Enamel Danger Signs:

1. General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

H. Engraved Plastic-Laminate Signs:

1. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/8", except as otherwise indicated.
3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.03 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC and OSHA.
2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Conduit Identification:

1. Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as coded color for conduit.

C. Box Identification:

1. After completion, using an indelible wide tip marker, indicate on the cover of each junction and pull box the designation of the circuits contained therein, i.e., A-1, 3, 5. Use a black marker for normal power circuits and a red marker for emergency circuits.

D. Underground Conduit Identification:

1. During back-filling/top-soiling of each exterior underground electrical, signal or communication conduit, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
2. Install line marker for every buried conduit, regardless of whether direct-buried or protected in conduit.

E. Cable/Conductor Identification:

1. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work. Refer to WIRES AND CABLES section of these specifications for color coding requirements.

F. Operational Identification and Warnings:

1. Wherever required by OSHA or directed by the Owner, to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities equipment by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

G. Danger Signs:

1. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work or the Owner as constituting similar dangers for persons in or about project.
   a. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
   b. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

H. Equipment/System Identification:

1. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/-control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
   a. Panelboards, electrical cabinets and enclosures.
   b. Access panel/doors to electrical facilities.
   c. Major electrical switchgear.
   d. Motor control centers.
   e. Transformers.
   f. Power generating units.
   g. Automatic transfer switch.
2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate. Identification of flush mounted cabinets and panelboards shall be on the inside of the device.

3. Panelboards, individually mounted circuit breakers, and each feeder breaker in the distribution panels shall be identified with an engraved plastic laminate sign. Plastic nameplates shall be multicolored laminated plastic with faceplate and core as scheduled. Lettering shall be engraved minimum 1/4" high letters.
   a. 480/277 volt normal power equipment shall be identified with white faceplate with black core.
   b. 480/277 volt emergency power equipment shall be identified with white faceplate with red core.
   c. 208/120 volt essential power equipment shall be identified with red faceplate with white core.
   d. Equipment identification is to indicate the following:
      1) Equipment ID abbreviation.
      2) Voltage, phase, wires and frequency.
      3) Emergency or other system.
      4) Power source origination. Example:
         a) Panel E3HA
         b) 480/277V, 3 phase, 4 wire
         c) Emergency System
         d) Fed by SWBD-7

END OF SECTION

DIVISION 26 – ELECTRICAL

260573 – SHORT-CIRCUIT COORDINATION STUDY/ARC FLASH

PART 1 - GENERAL

1.01 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies which shall be prepared by the equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.02 RELATED SECTIONS

1.03 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace
3. submittals for review/approval

D. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.04 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:

1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
6. Incident energy and flash protection boundary calculations
7. Comments and recommendations for system improvements, where needed
8. Executive Summary including source of information and assumptions made

1.05 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCT

2.01 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480 Volt motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.02 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.03 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility’s supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating

5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.04 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:

1. Electric utility's protective device
2. Medium voltage equipment relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points
9. Pertinent generator short-circuit decrement curve and generator damage point
10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.05 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all 480V locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.06 REPORT SECTIONS

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
2. Short-circuit reactance of rotating machines with associated X/R ratios
3. Cable type, construction, size, # per phase, length, impedance and conduit type
4. Bus duct type, size, length, and impedance
5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:

1. Source fault impedance and generator contributions
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA

6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
   a. Current transformer ratio.
   b. Current setting.
   c. Time setting.
   d. Instantaneous setting.
   e. Specialty non-overcurrent device settings.
   f. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground).
   b. Adjustable time-current characteristic.
   c. Adjustable instantaneous pickup.
   d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.01 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.02 ARC FLASH WARNING LABELS

A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
2. For each motor control center, one arc flash label shall be provided
3. For each low voltage switchboard, one arc flash label shall be provided
4. For each switchgear, one flash label shall be provided
5. For medium voltage switches one arc flash label shall be provided

E. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.03 ARC FLASH TRAINING

A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals.

END OF SECTION

DIVISION 26 – ELECTRICAL

262200 – TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of the furnishing, connection and installation of dry type transformers.

B. Definition: Dry type transformers, as described herein, applies to those with primary and secondary voltage connections of 600 volts and less. Autotransformers are not acceptable, except where indicated for buck boost or zig-zag connections.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.

1. Underwriter's Laboratories, Inc. (UL) Publications:
   a. No. 506 Transformers (1000 KVA, 3 phase and below; 167 KVA, 1 phase and below)
2. National Fire Protection Association (NFPA):
   a. No. 70 National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA):
   a. No. ST-20 Dry-type transformers for general applications
4. American National Standards Institute (ANSI):
   a. No. C57.12.80 Terminology for Power and Distribution Transformers
   b. No. C57.12.90 Guide for Short Circuit Testing of Distribution and Power Transformers
   c. No. C57.94 Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Eaton
2. General Electric
3. Square D

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure transformer access and clearance minimums are provided, and adequate ventilation is permitted.

1.04 SUBMITTALS

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Manufacturers Product Data:

1. Submit material specifications and installation data for products specified under PART 2 - PRODUCTS. Product data shall indicate sound and temperature rating, overload capacity and efficiency at 25%, 50% and 100% load, available taps, voltage, impedance, nameplate data, wiring diagrams, physical dimensions and net weight. Product data shall also contain certification that transformers are constructed and tested in accordance with standards specified herein.

C. Record Drawings. Include in each set:

1. A complete set of manufacturers product data indicating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein and indicated on the drawings.

B. All transformers shall be UL listed and bear a UL label.

C. Transformers shall be self-cooled, rated for continuous operation at rated KVA, 24 hours per day, 365 days per year with normal life expectancy (IEEE Standard No. 65). KVA ratings shall be as indicated on the drawings.

2.02 GENERAL PURPOSE DRY TYPE TRANSFORMERS

A. Insulation System

1. Single phase 25 - 167 KVA and three phase 30 - 1500 KVA: Transformers shall be rated for average temperature rise by resistance of 150°C. in 40°C. maximum ambient, 30°C average ambient. Transformer insulation system shall be UL rated as 220°C. system.
2. Three phase 3 - 15 KVA: Transformers shall be rated for average temperature rise by resistance of 115°C. Insulation system shall be 180°C.

3. Single phase up through 250 VA: Transformers shall be rated for 55°C. rise by resistance. Insulation system shall be 105°C.
4. Single phase 500 - 3000 VA: Transformers shall be rated for 115°C. temperature rise by resistance. Insulation system shall be 180°C.

B. Sound rating shall not exceed NEMA and ANSI standards for KVA rating. Internal vibration dampening shall be provided as a standard feature of all transformers.

C. Single phase transformers rated up to 15 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All other single phase and all three phase transformers shall be provided with six 2-1/2% full capacity taps, two above and four below normal voltage unless only four 2-1/2% taps, two above and two below normal voltage, are standard.

D. Construction and Enclosures

1. Transformers 30 - 1500 KVA: Transformer enclosures shall be open, ventilated, drip-proof with removable front and rear cover panels. Transformers shall be suitable for floor mounting, unless wall mounting is indicated on the drawings.
2. Transformers up through 25 KVA: Transformers shall be totally enclosed, non-ventilated with a resin encapsulated core and coil and drip-proof housing. Removable panel section shall permit access to wiring compartment.

E. Dry type transformers shall provide 3 phase 4 wire 208Y/120 or 1 phase 3 wire 230/115 volt service, as indicated on the drawings, to designated panelboards or other equipment. Primary rating shall be 480 volts.

F. Nominal transformer impedance shall be 4.5 percent minimum, unless otherwise indicated on the drawings.

G. Dry type transformer K-factors shall be as indicated on the drawings and as outlined in ANSI C57.110 "Recommended Practice for Establishing Transformer Capability when Supplying Nonsinusoidal Load Currents."

H. Core assemblies and the center ground connection point of the coil secondaries shall be grounded to their enclosures by adequate, flexible ground straps. Provide grounding lug at the strap to enclosure bonding location for connection of three conductors; the primary and secondary equipment grounding conductors and the grounding electrode conductor.

I. Provide weather shield on transformers indicated on drawings and for all exterior installations.

2.03 BUCK-BOOST TRANSFORMERS

A. Buck-boost transformers shall comply with the requirements of General Purpose Dry Type Transformers, and have the additional features specified herein.

B. Buck-boost transformers shall be connected to provide the voltage modification indicated. Transformers shall be single phase, two winding, dry type transformers, UL listed and labeled as suitable for connection as autotransformer for buck-boost applications. KVA rating shall be for load to be served with autotransformer connections.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Dry transformers larger than 15 KVA shall be floor mounted, unless wall or suspension mounting is indicated on the drawings. Transformers 15 KVA and smaller shall be wall mounted. Installation shall provide not less than twelve inch clearance from walls or equipment. Floor mounted transformers shall be mounted on neoprene, waffle type vibration pads 5/8" thick. Where transformers are indicated on the drawings, or specified herein to be mounted on suspended channels of angles or wall mounted, transformers shall be bolted to structure with 5/8" thick vibration pad between transformer base and structural surface. Loosen shipping bolts to free up internal vibration mounts on core and coil assembly.

B. Primary and secondary connections to dry type transformers shall be made with flexible conduit.

C. The secondary windings of each dry type transformer shall be grounded in accordance with the National Electrical Code requirements for separately derived electrical systems. Extend a grounding electrode conductor from the transformer grounding lug to the nearest building structural steel or main column rebar. Connect the primary and secondary feeder equipment grounding conductors to the grounding lug. Refer to the secondary grounding section of these specifications for additional requirements.

D. Install secondary overcurrent protective device within 10 feet of conductor length. Where none is indicated on plans, provide enclosed circuit breaker within 10 feet rated at 125 percent of the transformer full load ampacity but not greater than the secondary conductor ampacity.

E. Do not install equipment over transformer, unless indicated on the drawings.

F. Locate transformers to provide working clearance and full accessibility as required by the National Electrical Code.

G. For the installation of buck-boost transformers, where three phase load is to be served, three single phase transformers are required. Provide 4" x 4" x 24" wiring trough with hinged cover for both primary and secondary interconnections. Connection to wiring trough from transformer shall be with flexible conduit.

3.02 CLEANING AND ADJUSTMENT

A. Prior to final inspection, under maximum available load, measure secondary voltage and adjust tap setting to deliver nominal rated voltage within the percentage limits of one tap setting. Record the voltages of each transformer and submit in accordance with the requirements specified in the basic electrical requirements section.

B. After completion, clean the interior and exterior of dirt, paint and construction debris.

C. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.03 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.04 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

END OF SECTION

DIVISION 26 – ELECTRICAL

262413.01 – SWITCHBOARDS – FRONT ACCESSIBLE GROUP MOUNTED FEEDER DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the Specifications consists of the installation of all switchboards [designated on the drawings to have group mounted feeder devices with front access only construction] for use on systems 600 volts and below. All materials and devices which are an integral part of the switchboard shall be provided under this section of the specifications.

B. Definition: Switchboards are floor mounted assemblies of one or more enclosed vertical section containing circuit breakers, switches, meters, fuses, and terminals essential to operation of electrical equipment. A dead front switchboard has no exposed live parts on front.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. National Electrical Manufacturers Association (NEMA) Standards:
   a. PB-2: Dead Front Distribution Switchboards
   b. PB-2.1: General Instruction for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards rated 600 volts or less.
   c. SG-3: Low Voltage Power Circuit Breakers.
2. Underwriters Laboratories, Inc. (UL):
   a. UL-489: Molded Case Circuit Breakers and Circuit Breaker Enclosures
   b. UL-891: Deadfront Electrical Switchboards
   c. UL-977: Fused Power Circuit Devices
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. STD-241: IEEE Recommended Practices for Electric Power Systems in Commercial Buildings
4. National Fire Protection Association (NFPA):
   a. NFPA-70: The National Electrical Code

5. American National Standards Institute (ANSI):
   a. C37.13: Low-Voltage AC Power Circuit Breakers used in Enclosures
   b. C37.16: Related Requirements and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Protectors, Preferred Ratings

B. Equipment Dimensions

1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where switchboards of acceptable manufacturers listed exceed the maximum dimensions, products of such manufacturers shall not be acceptable.

C. Coordination

1. Review shop drawings submitted under this and other sections, as well as other divisions, to ensure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with engineering and structural features, equipment installed under other sections of the specifications and electrical equipment to insure access and so that clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Product Data: Switchboards including, but not limited to, voltages, number of phases, frequencies, and short-circuit and continuous current ratings. Provide application data for main and branch circuit-breakers, sections, main buses, and basic insulation levels.

C. Shop Drawings: Layout drawings of switchboards showing accurately scaled basic equipment sections including auxiliary compartments, section components, and combination sections.

D. Wiring Diagrams: For switchboards showing connections to electrical power feeders and distribution branches. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

E. Closeout Submittals: As follows:

1. Record Drawings: Include in each set:

F.

1. Complete set of switchboard manufacturers' product data and shop drawings indicating all post bid revisions and field changes.
2. Schedule of each overcurrent protection device indicating unit ampere rating and trip rating.

3. Copy of the ground-fault system performance test as required by Article 230-95(c) of the NEC.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Deliver switchboards and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for switchboards and components which protect equipment from damage. Install gravity measuring meters in containers which indicate whether container has been bumped or dropped. Return G-meters to manufacturer for re-use upon delivery of switchboards. Inspect equipment to ensure that no damage has occurred during shipment.

B. Store switchboard equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle switchboard equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.06 SEQUENCING AND SCHEDULING

A. Schedule delivery of switchboard equipment which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.

B. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.

C. Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of switchboards with other work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton
2. General Electric
3. Square D

2.02 GENERAL

A. AC Dead-Front Distribution Switchboards: Provide factory-assembled, dead-front, metal-enclosed, self-supporting secondary power switchboards, of types, sizes, electrical ratings and characteristics indicated; consisting of vertical panel units, and containing circuit-breakers of quantities, ratings and types indicated. Provide copper main bus and connections to circuit-breaker branches of sufficient capacity to limit rated continuous current operating temperature rise of no greater than 65°C above average ambient temperature of 25°C; with main bus and tap connections silver-surfaced and bolted tightly according to manufacturer's torquing requirements for maximum conductivity. Brace bus for short-circuit stresses up to maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Equip units with built-in lifting eyes and yokes; and provide vertical individual panel units, suitable for bolting together at project site. Construct switchboard units for the following environment:

1. Installation: Indoors, NEMA Type 1.

B. Provide accessory and instrumentation small wiring, necessary fuse blocks and terminal blocks within the switchboard. Control components, such as control transformers, fuse blocks, relays, etc., shall be suitably marked for identification where mounted on the switchboard corresponding to appropriate designations on manufacturer's wiring diagrams. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

2.03 BUSSING

A. All bus bars shall be silver-plated copper with bolted connections at joints. The bus bars shall be of sufficient size to limit the temperature rise to 65°C rise based on UL tests, and rated to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having an available fault current as shown on the drawings. Provide full capacity neutral where a neutral is indicated on the drawings.

B. A ground bus rated a minimum of 25% of main bus ampacity shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. An incoming ground lug shall be furnished. Other ground lugs for feeder circuits shall also be supplied as shown in the schedules on the drawings.

C. All hardware used on conductors shall be high-tensile strength and plated. All terminals shall be of the anti-turn solderless type suitable for CU or A1 cable of sizes indicated for 75°C cable.

2.04 CONSTRUCTION

A. Switchboards shown mounted against a wall shall be front accessible. All sections of the switchboard shall be 20" deep except service sections containing large ampacity main disconnects which may be deeper as required. All sections of the switchboard shall align so that the back of the complete structure may be placed flush against a wall.

B. Construction shall allow maintenance of incoming line terminations, main device connections and all main bus bolted connections to be performed without rear access. The feeder or branch devices shall be removable from the front and shall be panel mounted with the necessary device line and load connections front accessible. Provide lugs on all devices for cable sizes shown on drawings.

2.05 METERING

A. Where indicated on the drawings, provide a separate customer metering compartment with front hinged door and include the following:

1. Current transformers
2. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.
3. Indicating ammeter with ammeter switch indicating voltmeter with voltmeter switch and KWHR demand meter.

2.06 OVERCURRENT DEVICES - GENERAL

A. Main protective devices shall be fixed mounted molded case breaker with interrupting rating, frame and trip ratings as shown on the drawings.

B. Group mounted feeder protective devices shall be molded case breaker type with frame and trip rating as shown on the drawings and have additional characteristics as specified.

C. Devices shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings.

2.07 MOLDED CASE BREAKERS

A. Protective devices as shown shall be molded case circuit breakers providing complete circuit overcurrent protection by having inverse time and instantaneous tripping characteristics, and where applicable, be current limiting.

1. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip free. Automatic tripping of the breaker shall be clearly indicated by handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.

2. Circuit breaker interrupting capacities shall be as indicated on the drawings or as specified hereinafter. Where applicable, circuit breakers shall be listed for series application.

B. Breakers 150 ampere and below shall be thermal-magnetic trip with inverse time current characteristics. Breakers with 250 and 400 ampere frame shall be thermal-magnetic or solid-state trip, as applicable.

C. Breakers with 600 amperes frame and above shall be solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have trip rating plugs with ratings as indicated on the drawings. Rating plugs shall be interlocked so they are NOT interchangeable between frames and interlocked such that a breaker cannot be latched with the rating plug removed.

1. Trip units shall have adjustable short time setting with a fixed instantaneous override for circuit protection. Main breakers shall be provided with additional instantaneous and short delay trip time adjustment for increased system coordination.
2. Breakers shall have built-in test points for testing long delay, instantaneous and ground fault functions of the breaker by means of a 120 volt operated test kit. Provide one test kit capable of testing all breakers 600 ampere and above.
3. Where indicated on the drawings, provide built-in ground fault protection with adjustable pick-up rating not exceeding 1200 amperes; ground fault time delay shall be adjustable 0.1 to 0.5 seconds. Provide neutral ground fault current transformer for four wire systems.

D. Where indicated on the drawings, provide zero sequence ground fault protection system with necessary sensor, monitor, test panel, shunt trip and control power source for use with breakers indicated.

2.08 NAMEPLATES

A. Engraved nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number. Refer to ELECTRICAL IDENTIFICATION section of this specification.

2.09 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 and use the manufacturer's standard process.

2.10 CONTROL POWER TRANSFORMERS

A. Control power transformers with primary and secondary protection shall be provided as indicated on the drawings or where required to operate ground fault systems, adequately sized for required burdens.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions under which switchboards and components are to be installed, and notify General Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF SWITCHBOARDS:

A. Install switchboards as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of NEC, NEMA's Stds Pub/No. PB 2.1, and NECA's "Standard of Installation".

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486 A and B, and the National Electrical Code.

3.03 FIELD QUALITY CONTROL

A. Refer to ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

3.04 ADJUSTING AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finishes.

3.05 GROUNDING

A. Provide equipment grounding connections for switchboards as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.06 FIELD QUALITY CONTROL

A. Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

DIVISION 26 – ELECTRICAL

262416 – PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of the furnishing, installation and connection of lighting and appliance panelboards and distribution type panelboards.

B. Panelboards designated as HDA, HDB, DA, DB, etc., or indicated on the drawings shall be distribution type panelboards. Those designated as HA, HB, A, B, etc., are lighting and appliance type panelboards.

C. Definitions: The term panelboard, as used in this specification or on the drawings, shall mean the complete assembly including the enclosure, bus work, trim hardware and circuit breaker or fused devices. The words panel and panelboard are used synonymously in these contract documents.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 50: Cabinets and Boxes, Electrical
   b. No. 67: Panelboards
   c. No. 489: Molded Case Circuit Breakers and Circuit Breaker Enclosure
2. Federal Specifications (Fed Spec):
   a. WC-375: Circuit Breakers
3. National Electrical Manufacturer's Association (NEMA) Publications:
   a. No. PB-1: Panelboards
   b. No. AB-3: Molded Case Circuit Breakers
4. National Fire Protection Association (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. General Electric
2. Eaton
3. Square D

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure panel access and insure that clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to BASIC ELECTRICAL REQUIREMENTS for submittal requirements.

B. Manufacturers Product Data:

1. Submit material specifications and installation data for products specified under Part 2 - Products to include:
   a. Circuit breakers
   b. Panelboards

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.

1. Include electrical characteristics and ratings for each panelboard with dimensions, mounting, bus material, voltage, ampere rating, mains, poles and wire connection, and any accessories. Indicate method of ground bus attachment to enclosure.
2. Include front elevation bussing diagram indicating each bussing circuit breaker position.
3. Provide a schedule indicating circuit breaker type, trip and size, poles, frame type, and interrupting capacity.

D. Record Drawings. Include in each set:

1. A complete set of panelboard manufacturers product data and shop drawings indicating all post bid revisions and field changes.
2. A copy of each panelboard directory incorporating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All panels and circuit breakers shall be UL listed and bear a UL label.

C. Panels shall be of the dead front safety type.

D. Provide panels complete with factory assembled circuit breakers connected to the bus bars in the positions shown on the panel schedules or bus diagrams as indicated on the drawings.

E. Number all panelboard circuits in the following sequence:

1. Circuits No. 1 and 2, Phase A; Circuits No. 3 and 4, Phase B; Circuits No. 5 and 6, Phase C. Connect two pole breakers to phase indicated on the drawings.

2.02 BUSSING AND INTERIORS

A. All bus bars shall be copper. Main lugs and main breakers shall be UL approved for copper or aluminum conductors and shall be of a size range for the conductors indicated on the drawings. Each panel shall contain an equipment grounding bus. Each lighting and appliance panelboard shall contain a full size insulated neutral bus. Where a distribution type panelboard is indicated on the drawings to have a neutral bus, the bus shall be insulated and full size, unless otherwise indicated on the drawings.

B. The neutral and ground busses shall have a sufficient number of lugs to singularly terminate each individual conductor requiring a connection.

C. The ground bus shall be factory brazed, riveted or installed on studs bolted to the panel enclosure or panel frame. The ground bus shall not be attached to the panel interior.

D. Where designated on panel schedule as "space", include all necessary bussing, device support and connections. Provide blank cover for each space.

2.03 ENCLOSURES

A. Panelboard width shall not be less than 20", nor more than 22" unless specific width is indicated on the drawings. Panelboard depth shall not exceed 5-3/4".

B. Distribution panelboard width shall not be less than 31" and the depth shall not exceed 14".

C. Review panelboard schedules and system one line diagram and provide panelboard gutters and bending space at terminals to conform to the National Electrical Code.

D. Provide concealed captive clamping devices, concealed hinges and lock for all flush mounted panels. Key all panels throughout project alike.

E. All surface mounted panels shall be provided with door-in-door hinged cover trims. Trims shall be secured by piano hinges to enclosure and secured closed by two trim clamps.

F. Provide a directory card, metal holder, and transparent cover permanently mounted on inside of doors.

G. Where indicated on the drawings or required for the environmental conditions, provide a NEMA 12 enclosure.

2.04 CIRCUIT BREAKERS

A. Interrupting rating of all circuit breakers in panelboards operating on 208Y/120 volt system shall have UL rating of not less than 10,000 RMS symmetrical amps at system voltage. Panelboards for use on 480Y/277 volt system shall contain circuit breakers with UL interrupting rating of not less than 14,000 RMS symmetrical amps at system voltage. Provide circuit breakers with higher interrupting capacity when indicated on the drawings.

B. Circuit breakers shall be provided with trip rating, poles and minimum interrupting rating as indicated on the drawings or specified herein.

C. Multi-pole breakers shall be common trip and common reset; tie handle connection between single pole breakers is not acceptable.

D. Branch circuit breakers in lighting and appliance panels shall be quick-make, quick-break, thermal magnetic type bolted to the bus. Circuit breakers in distribution type panelboards shall be bolted to the bus except, Square D I-line style plug in devices are acceptable.

E. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame or less. Magnetic trip shall be adjustable for breakers with 600 ampere frames and higher. Factory setting shall be HI, unless otherwise noted.

F. Provide the following special devices and accessories when indicated on the drawings, specified herein, or required by the NEC.

1. Ground fault interrupting circuit breaker (GFI).
2. Provide handle lock-off device to prevent manually turning off device without removal. Install on all circuit breakers indicated on the panel schedule.

2.05 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS

A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified for panelboards.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount panelboards with top circuit not more than 6'-6" above finished floor.

B. Lace and group conductors installed in panels with nylon tie straps. Only one conductor shall be installed under terminal of individual circuit breakers. Form and train conductors in panel enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug.

C. Do not splice conductors in panels. Where required, install junction box adjacent to panel and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the conductors and cables section of the specifications and do not exceed.

D. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
   b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
   c. Attach enclosure directly to masonry, concrete, or wood surfaces.
   d. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure or sheet rock walls.

E. Conductors not terminating in panelboard shall not extend through or enter panel enclosure.

F. Maintain conductor phase color code requirement described in the wires and cables section of the specifications.

G. Provide in each panelboard with a typewritten circuit directory mounted under clear plastic in a metal directory frame on interior of panel door. Directory shall reflect any field changes or additions.

H. Install push-in knock-out closure plugs in any unused knock-out openings.

I. Identification

1. Panelboards and individually mounted circuit breakers shall be identified.
2. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

C. Adjust and align panelboard interior and trim in accordance with manufacturers recommendations, and to eliminate gaps between the two.

3.03 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

END OF SECTION

DIVISION 26 – ELECTRICAL

262419 – MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.02 SUMMARY

A. The work required under this section of the Specifications consists of the installation of all Motor Control Centers for use on systems 600 volts and below. All materials and devices which are an integral part of the Motor Control Center shall be provided under this section of the specifications.

B. Definition: Motor Control Centers are floor mounted assemblies of one or more enclosed vertical sections having a common horizontal power bus and primarily containing combination Motor Control Units. Units are mounted one above the other in the vertical sections, with power supplied to the individual units by vertical power busses. The words motor control units, starters, and motor controllers are used synonomously in these contract documents.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. National Electrical Manufacturers Association (NEMA) Standards:
   a. ICS-1: General Standards for Industrial Control and Systems
   b. ICS-2: Industrial Control Devices, Controllers and Assemblies
   c. ICS-3: Industrial Systems
   d. ICS-4: Terminal Blocks for Industrial Control Equipment and Systems
   e. ICS-6: Enclosures for Industrial Controls and Systems
2. Underwriters Laboratories, Inc. (UL) Publications:
   a. UL 198.4: Class R Fuses
   b. UL 508: Industrial Control Equipment
   c. UL 845: Standard for Motor Control Centers
3. National Fire Protection Association (NFPA)
   a. NFPA 70: National Electrical Code
4. American National Standards Institute (ANSI):
   a. C97.1: Low Voltage Cartridge Fuses, 600 Volts or Less

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Motor control centers and controllers:
   a. Square D
   b. General Electric
   c. Eaton
2. Fuses:
   a. Gould-Shawmut
   b. Buss
   c. Littlefuse

C. Equipment Dimensions

1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where motor control centers of acceptable manufacturers listed exceed the maximum dimensions, products of such manufacturers shall not be acceptable.

D. Coordination

1. Review shop drawings submitted under this and other sections, as well as other divisions, to ensure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure access and so that clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to basic electrical requirements section for submittal requirements.

B. Manufacturer's Product Data:

1. Submit material specifications and installation data for products specified under Part 2 - Products to include:
   a. Motor controllers
   b. Motor control centers
   c. Fuses

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.

1. Include electrical characteristics and ratings for each motor control center with dimensions, mounting, bus material, voltage, bracing, ampere rating, mains, poles and wire connection, and any accessories.
2. Include bussing diagram indicating each bussing motor control unit, circuit breaker, or fused switch position.

3. Provide a schedule indicating motor control unit type, or trip and size, poles, frame type, fuse size and type, and interrupting capacity.
4. Identification designation schedule.

D. Record Drawings - Include in each set:

1. A complete set of motor control center manufacturers product data and shop drawings indicating all post bid revisions and field changes.
2. A schedule of each motor's actual full load nameplate rating and NEMA design with the selected overload heater catalog number and current range.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish all materials specified herein.

B. Motor control center, motor control units, circuit breakers, and fused devices shall be UL listed and bear the UL label.

C. The type of enclosure shall be in accordance with NEMA standards for Type 1, gasketed construction. All enclosing sheet steel, wireways and unit doors shall be gasketed.

D. The motor control center shall be suitable for operation on a 277/480 3-phase, 4-wire 60 Hz system.

E. Motor control center wiring shall be NEMA Class I type B.

2.02 STRUCTURE ARRANGEMENT

A. Motor Control Center shall consist of free-standing, standardized vertical sections; each section shall have the following nominal dimensions: 90" H. x 20" W. x 16D. Maximum overall dimensions, not to be exceeded, shall be as indicated on the drawings.

B. Each section shall contain continuous horizontal and vertical wireways. The horizontal wireway shall be located at the top and bottom of the section. Vertical wireways shall be provided adjacent to each unit. All wireways shall have provisions for cable support, shall be isolated from the bus bars and shall be accessible through hinged doors held closed by captive screws.

C. Adequate space for conduit and conductors entering the top or bottom, in accordance with the National Electrical Code, shall be provided without structural interference. Conductors shall be safely accessible without disrupting service.

D. Individual sections shall be assembled to form a totally enclosed deadfront, front accessible motor control center, as indicated on the drawings.

E. Motor control center design shall permit the future installation of matching vertical sections without the need for transition sections.

2.03 BUS ARRANGEMENT

A. Each vertical section shall contain a continuous three-phase bus, rated as shown on the drawings. Vertical busses shall be connected to the main horizontal bus.

B. A continuous, three-phase, main horizontal bus, rated as shown on the drawings, shall be provided for the distribution of power to the vertical busses. The main bus shall be located in the upper part of the structure.

C. Each vertical section shall contain a neutral bus connected to a main horizontal neutral bus, all rated at 50% of the main bus rating.

D. All non-current-carrying parts of the control center shall be grounded through the use of a continuous horizontal ground bus connected to vertical ground busses in each section. Ground bus rating shall not be less than 25% of main bus rating. Bus design shall include feature that for any plug-on unit the ground bus stab shall make contact with the ground bus before the power bus contact is made.

E. All busses shall be tin-plated copper, rated for a 50 degrees C. temperature rise above a 40 degrees C ambient. The minimum bus bracing, in RMS - symmetrical-amperes, shall be as shown on the drawings. Busbars shall be isolated and insulated with polyester boards front and back.

F. A front accessible main lug compartment shall be provided for incoming line termination. Lugs shall be suitable for terminating the size and quantity of conductors as indicated. The compartment shall be located in the unit space shown on the drawings and shall have a hinged door held closed by captive screws. Door shall have provisions for a padlock.

2.04 UNIT CONSTRUCTION

A. Combination magnetic starters shall be installed in removable units constructed in basic heights of 12" or multiples thereof. Each unit shall be isolated from others on structure. Connection to vertical bus for NEMA size five across the line starters and smaller shall be made with draw out stab type connection. Each plug-in type unit shall have a provision for positive horizontal and vertical alignment. Provisions shall also be included for positive ground connections through plug-in facilities. Each magnetic starter shall contain a solid state overload relay in each phase. Each unit shall contain separable control terminal blocks and separable power terminal blocks to permit removal of unit without disturbing control wiring.

B. Magnetic starters shall be the combination type with molded case circuit breakers. UL listed interrupting rating of molded case circuit breakershall not be less than indicated on the drawings at system voltage.

C. Reduced voltage magnetic starters shall be combination, closed transition, solid state type.

D. Individual starter doors and individual overcurrent device doors shall be interlocked to prevent door from being opened until switch is in "OFF" position. However, a "cheater screw" or other inconspicuous means shall be provided to permit access to energized starter, by authorized personnel. An interlock contact shall be provided within the starter to open control circuit to magnetic starter when device handle is in the open position. A door activated interlock switch is not acceptable.

E. Each starter shall be provided with HOA switch, as indicated on the drawings. Where no device is indicated on the drawings, provide an HOA switch for any motors automatically controlled or an ON-OFF switch for those specified to be manually controlled. Provide each magnetic starter with a "RUN" and an "OVERLOAD" pilot lamp. Control devices shall be of oil tight construction and shall be mounted on a removable panel on the unit door. Identify each control device with a metal tag or plastic laminated label.

F. Overload protection shall be adjustable and manually reset solid state type shall be selected in accordance with full load rating of motors actually furnished. Relay switching mechanism shall be single pole, double throw with normally open position connected to operate a door mounted, oil tight blue pilot lamp to indicate starter has tripped on overload.

G. Control voltage for magnetic starters shall be 120 volts obtained from a individual control power transformers in each starter. Each control power transformer shall be fused.

H. Provide contacts in magnetic starters to provide interlocking control sequence of operation specified under Division 15. Provide one normally open and one normally closed spare auxiliary contact in each starter.

I. Starter sizes are based on design conditions using horsepower ratings of motors indicated on drawings. If motors actually furnished have horsepower ratings other than those indicated, motor starters and feeders shall be adjusted in accordance with the rated horsepower at no additional cost to the Owner.

J. Provide, where indicated, molded case circuit breakers for feeder protection. All circuit breakers shall have UL interrupting rating of not less indicated on the drawings, at system voltage.

K. Variable Frequency Drives (VFD)

1. References
   a. The VFD controller shall meet or exceed the requirements within the following standards for VFDs.
      1) NFPA 70
      2) UL 508C
      3) NEMA ICS 3.1
      4) NEMA 250
      5) IEEE 519

      IEEE 519 Reference Table

      NOTE: Vendor to provide harmonic analysis study as part of submittal process to ensure provided equipment is in compliance with this standard.

      Harmonic Current Distortion Limits (I_h and TDD) in % of I_L (≤ 69kV)

I_{SC}/I_L Ratio	I_h <11	11≤ I_h <17	17≤ I_h <23	23≤ I_h <35	TDD
<20	4.0	2.0	1.5	0.6	5.0
20-50	7.0	3.5	2.5	1.0	8.0
50-100	10.0	4.5	4.0	1.5	12.0
100-1000	12.0	5.5	5.0	2.0	15.0
>1000	15.0	7.0	6.0	2.5	20.0

      The voltage distortion guidelines for IEEE-1992 (at 480V) remain the same as IEEE 519-1981:

      3% - Special systems (i.e. hospitals or universities)
      5% - General systems
      10% - Dedicated systems (AFD's only)

      NOTE: The point of analysis shall be the secondary side of the utility transformer. (480V)

2. Design Requirements
   a. Provide VFD controllers in accordance with the detailed specifications and plans.
3. Submittals
   a. Shop drawings are required with the following:
      1) Fault ratings.
      2) Unit descriptions, including amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, pilot devices, etc.
      3) Schematic wiring diagrams.
4. Warranty
   a. The VFD manufacturer shall provide a Parts and Labor warranty for the VFDs that extends 24 months from the date of start-up or 18 months from the date of Project Acceptance, whichever expires first.
5. Manufacturers
   a. Square D Altivar 61
   b. Eaton SVX9000
   c. Danfoss VLT Aqua

d. GE AF-650

6. Ratings
   a. Voltage: Unless shown differently on the plans, the VFD shall be rated for a 480V (+/- 10%), 3-phase system.
   b. For VFD controllers greater than 5HP, the displacement power factor shall range between 1.0 and 0.95 lagging, over the entire speed range.
   c. Efficiency: Minimum of 97% at full load and speed.
   d. Environmental Ratings:
      1) Operating ambient temperature range (NEMA 4X): 0° C to 40° C.
      2) Relative humidity range: 5% to 95% non condensing.
   e. Output Power Ratings:
      1) The output voltage shall be adjustable from 0 to rated motor voltage.
      2) The output frequency range shall be adjustable from 0 to 320 Hz.
      3) The inverter section shall produce a pulse-width-modulated (PWM) waveform using latest generation insulated gate bipolar transistors (IGBTs).
   f. Sizing:
      1) Unless otherwise noted on the plans, all loads are normal-duty loads.
      2) The VFD manufacturer shall size each VFD based on the following normal-duty requirements:
         i. VFD continuous output amps rating shall be higher than the Full Load Amps (FLA) of the motor that it is to control.
         ii. VFD 1-minute overload output amps rating shall be a minimum of 110% higher than the FLA of the motor that it is to control.
         iii. VFD 3-second overload output amps rating shall be a minimum of 150% higher than the FLA of the motor that it is to control.
7. Enclosure
   a. The VFD shall be mounted within the motor control center.
8. VFD Controller Features
   a. Overload Protection
      1) The drive shall provide internal Class 10 motor overload protection investigated by UL to comply with N.E.C. Article 430.
      2) Overload protection shall be speed sensitive and adjustable.
   b. Terminal Blocks
      1) Separate terminal blocks shall be provided for control and power wiring.
   c. Flying Start
      1) The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to “pick up” the motor at the rotating speed.
9. VFD System Options
   a. Harmonic Mitigation
   b. High System Harmonic Influence VFD Controllers shall be provided with 3% line reactors and passive filters (IEEE 519 – 1992 compliant):

1) Other harmonic mitigation designs, including Active Filters and Active Front Ends, are not allowed.

c. Hand-Off-Auto Selector Switch
   1) Provide a "Hand/Off/Auto" selector switch for start-stop control.
   2) Provide pilot lights for indication of the "Hand" and "Auto" modes.
   3) The devices shall be NEMA Type 4/4X/12 (minimum 22.5mm diameter), mounted on the drive system enclosure door.

d. Pilot Lights
   1) Provide pilot lights, mounted on the enclosure door, for indication of Control Power On, Run, and Drive Fault (others if indicated on the plan drawings).
   2) The devices shall be NEMA Type 4/4X/12 (minimum 22.5mm diameter), mounted on the drive system enclosure door.

e. Speed Potentiometer
   1) Provide a NEMA Type 1/4/12 single turn speed pot mounted on the drive system enclosure door.

f. Communications
   1) Provide Ethernet/IP communications for remote control from SCADA.

10. Manufacturer's Services
    a. The VFD Manufacturer shall provide start-up services for the VFDs. The start-up services shall be performed by a trained Field Service Engineer who is an employee of the VFD manufacturer and a degreed engineer. All costs (travel, expenses, potential stand-by time) shall be included in the start-up services. The VFD manufacturer shall be responsible for coordinating with the Equipment Supplier and Installer to avoid/minimize stand-by time. Per VFD, a minimum of 4 hours on-site service shall apply for VFDs rated 77A or below. Per VFD, a minimum of 6 hours on-site service shall apply for VFDs rated above 77A.
    b. At a minimum, the start-up service shall include:
       1) Pre-Power Check
          i. Megger motor resistances: phase-to-phase and phase-to-ground.
          ii. Verify system grounding per manufacturer's specifications.
          iii. Verify power and ground signals.
          iv. Check connections.
          v. Check environment.
       2) Power-Up and Commissioning
          i. Measure incoming power: phase-to-phase and phase-to-ground.
          ii. Measure DC bus voltage.
          iii. Measure AC current: unloaded and loaded.
          iv. Measure output voltage: phase-to-phase and phase-to-ground.
       3) Record all measurements.
       4) Tune for system operation.
       5) Provide final parameter listing.

11. Training
    a. The VFD manufacturer shall provide (1) 6-hour on-site training course for up to 6 students on the basic operation, maintenance, and troubleshooting of the VFDs and reduced voltage solid state starters utilized on the project. If VFDs are supplied in a combination of Specification Sections by different Equipment Suppliers, then only one VFD training session is required. This training will be conducted on (1) trip. Coordination shall be the responsibility of the Equipment Suppliers. All costs (travel and expenses) shall be included.
    b. At a minimum, the training shall include:
        1) Review of the final plans identifying major components.
        2) Review starting/stopping procedures and options for the various controllers/starters.
        3) Review operation of the Human Interface Modules (if applicable for programming and monitoring of the system(s).
        4) Review the maintenance requirements of the system(s).
        5) Review safety concerns of the system(s).
        6) Hands-On Labs (max two students per VFD demo).
        7) Review of Support Sources and contacts

2.05 AUXILIARY EQUIPMENT

A. Identification:

1. The motor control center, each magnetic starter, each feeder protective device, and each auxiliary equipment item shall be provided with an engraved plastic nameplate approximately 1" x 3" permanently attached to the unit exterior door with self-tapping screws. Refer to ELECTRICAL IDENTIFICATION section.
2. Refer to the basic electrical requirements section of these specifications for nameplate requirements.
3. Submit complete schedule with the shop drawings listing all nameplates and information thereon.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install motor control center on 3" high concrete pad, the horizontal dimensions of which shall exceed the base dimensions of the motor control center by 3" on all sides.

B. Control and power circuits shall terminate in respective section in which starter is located.

C. Lace and group conductors installed in motor control center with nylon tie straps. Only one conductor shall be installed under each terminal. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eighth inch from terminal lug.

D. Do not splice conductors in motor control center. Where required, installed junction box adjacent to enclosure and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the wires and cables section section of the specifications and do not exceed.

E. Conductors not terminating in motor control center section or unit shall not extend through or enter the section or unit.

F. Maintain conductor phase color code requirement described in the wires and cables section of the specifications.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

C. Select and install overload heaters based on the full load current of the motor actually installed.

3.03 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.04 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

END OF SECTION

DIVISION 26 – ELECTRICAL

262726 – WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work included under this section of the specifications consists of the installation of wiring devices, i.e. switches and receptacles and device plates. All materials shall be provided under this section of the specifications.

B. Select devices from lists of acceptable devices contained in this section of the specifications.

C. The catalog numbers listed herein for switches and receptacles are for items with brown finish. Notwithstanding catalog numbers, the switches and receptacles provided on this project shall have white finish unless otherwise indicated. All special purpose receptacles shall be provided in black finish.

1.03 QUALITY ASSURANCE

A. NEMA WD-1 General Purpose Wiring

B. NEMA WD-5 Specific Purpose Wiring Devices

PART 2 - PRODUCTS

2.01 SWITCHES

A. Select switches from the following:

1. Single pole, 20 amp 277 volt switch: Arrow Hart 1991, Hubbell 1221, Leviton 53521, Pass & Seymour 20AC1.
2. Threeway, 20 amp 277 volt switch: Arrow Hart 1993, Hubbell 1223, Leviton 53523, Pass & Seymour 20AC3.
3. Four way, 20 amp 277 volt switch: Arrow Hart 1994, Hubbell 1224, Leviton 53524, Pass & Seymour 20AC4.
4. Weatherproof, 20 amp 277 volt switch: Arrow Hart 2991-2881G, Hubbell 1281-1750, Pass & Seymour 22515-4515.

5. Weatherproof, 20 amp 277 volt three way switch: Arrow Hart 2993/2881-G, Hubbell 1283-1750, Pass & Seymour 22535-4515.
6. Single pole, 20 amp 120 volt switch with pilot lamp in handle: Arrow Hart 2999-R, Hubbell 1221 PL.
7. Single pole 20 amp 277 volt switch with pilot lamp in handle: Arrow Hart 2999-I-277, Hubbell 1221-PL7.

2.02 RECEPTACLES

A. Select receptacles from those listed herein. Designation in parenthesis is NEMA configuration required.

1. 15 amp, 125 volt grounded duplex receptacle (5-15R): Arrow Hart 5262, Hubbell 5262, Leviton 5262, Pass & Seymour 5262.
2. 20 amp, 125 volt grounded duplex receptacle (5-20R): Arrow Hart 5739, Hubbell 5362, Leviton 5362.
3. Ground Fault Interrupter (GFI) 15 amp, 125 volt duplex receptacle: Leviton 6194, Arrow Hart 1591, Hubbell GF-5262, Pass & Seymour 1591-F.
4. Ground Fault Interrupter (GFI), 15 amp 125 volt duplex receptacle, through feed type: Arrow Hart 1591-F, Leviton 6399, Pass & Seymour 1591-F, Hubbell GF-5262.
5. Transient Voltage Surge Suppression (TVSS) receptacles shall comply with ANSI/IEEE C62.41 and LILI449 (July 1987) for categories A and B. Devices shall provide RFI and EMI noise filtration of not less than a 7:1 reduction. Devices shall suppress transients in each of 3 modes: Line-to-neutral, line-to-ground, and neutral-to-ground. Devices shall be provided with an LED for positive indication of failure of protective circuitry or audible alarm. Products complying with this specification manufactured by Arrow Hart, Hubbell, Leviton, or Pass and Seymour are acceptable.

2.03 DEVICE PLATES

A. Device plates shall be one piece single or multi-gang type selected to match the device or combination of devices. Device plates for flush mounted devices shall be type 302 stainless steel unless indicated otherwise.

1. Device plates for use with devices flush mounted in exposed masonry construction shall be jumbo type. Device plates for surface mounted devices shall be for use with the type of outlet box in which the device is mounted. All devices installed in areas exposed to the weather and where indicated on the drawings shall be provided with a weatherproof device plate.
2. Where engraved device plates are indicated on the drawings or specified in Division 16, engraving shall be done by the device plate manufacturer. All lettering shall be 1/8" high and shall be black unless other contrasting color is specified.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. The mounting height of devices are indicated in the legend on the drawings and is intended to mean the bottom of the device above the finished floor unless otherwise indicated on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.

B. Review Engineering Drawings for any device requiring specific location. Install receptacles above countertops with major axis horizontal above the backsplash.

C. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominate building feature, i.e., doorframes or countertops.

D. Install wall switches on the strike side of doors.

END OF SECTION

DIVISION 26 – ELECTRICAL

262816 – CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section covers disconnect switches for electrical equipment, 600V and below, and fuses mounted in the disconnect devices.

B. Furnish and install disconnect switches for any of the following conditions:

1. Where indicated on the drawings.
2. For all motors located out-of-sight of its motor controller.
3. For water heaters.
4. For electrical unit heaters.
5. Where required by the National Electrical Code.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 98: Enclosed Switches
   b. No. 198.2: High-Interrupting Capacity Fuses, Current Limiting Type
   c. No. 198.4: Class R fuses
2. National Fire Protection Association (NFPA) Publications:
   a. No. 70: National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA) Publications:
   a. No. KS 1: Enclosed Switches
4. Federal Specification (Fed Spec):
   a. No. WS-865-C

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:

1. General Electric
2. Eaton
3. Square D

C. Coordination: Coordinate installations with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure disconnect switch access and insure that clearance minimums are provided.

PART 2 - PRODUCTS

2.01 GENERAL MATERIAL REQUIREMENTS

A. Furnish all materials specified herein.

B. All disconnects and fuses shall be UL listed and bear a UL label.

C. Fuses shall be heavy duty, type HD horsepower rated as required for motor load served.

D. Switches shall be 600 volt rated, except for use in system below 240 volt, when they may be 250 volt rated. Switches shall be heavy duty rated. General duty switches are not acceptable.

E. Furnish a solid neutral for each switch being installed in a circuit which includes a neutral conductor.

F. Furnish an equipment grounding conductor lug bonded to the switch enclosure.

G. Disconnect switches shall be non-fusible safety switch, unless fused type is specified or indicated on the drawings, with the number of poles required to disconnect all ungrounded conductors serving equipment.

H. Enclosure shall be NEMA Type One in all interior dry locations and shall be NEMA Type 4X stainless steel in all damp, wet, or exterior locations, unless other type is indicated on the drawings or specified herein.

2.02 PRODUCT/MATERIAL DESCRIPTION

A. Switching mechanism shall be quick-make, quick-break type.

B. Where non-fused disconnect switches are indicated on the drawings or specified for use as disconnects, they shall be the non-fused type.

C. Switches shall have the following features:

1. Provide line terminal shields in all switches.
2. Each switch shall have provisions for padlocking in the "OFF" position.
3. Each switch shall have door interlocks to prevent door from being opened when switch is in closed position. Provide inconspicuous means to defeat interlock mechanism.

4. Provide permanent nameplate indicating switch rating in voltage, amperes and horsepower.
5. Arch chute for each pole.
6. Provide auxillary contacts (break-first/make-last) for VFD driven motors.

D. Disconnect switches for three phase motors rated two horsepower and above shall be three pole nonfusible type rated as indicated on the drawings. Disconnect switches for three phase motors rated below two horsepower shall be three pole manual motor starter switches without overload protection. Disconnect for single phase motors shall be single or two pole horsepower rated switches without overload protection.

E. Fusible switches through 600 amp shall be provided with rejection clips to accept RK1 or RK5 class fuses only. Fusible switches larger than 600 amp shall be suitable for class L fuses. Furnish and install a complete set of fuses in each disconnect sized as indicated on the drawings. Fuses serving predominantly motor or transformer loads shall be dual-element, time delay type, otherwise non-time delay fast acting type is required. Fuses shall be current limiting with 200,000 AIC.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate disconnect switches to maintain line of sight and to provide working clearance and full accessibility as required by the National Electrical Code.

B. Unless indicated otherwise on the drawings, locate disconnects adjacent to equipment served.

C. Lace and group conductors installed in disconnect with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond 1/8" from terminal lug.

D. Mounting and Support

1. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
2. Mounting
   a. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
   b. Attach enclosure directly to masonry, concrete, or wood surfaces.
   c. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure, sheet metal equipment enclosure, or sheet rock walls.

d. Where enclosure is not indicated on a wall or structure, construct a metal channel (strut) free standing frame secured to floor, pad, or other appropriate building structure. Refer to the detail on the drawing for frame installation and construction information.
e. Mount switch with handle between 36" and 60" above floor or grade, unless otherwise indicated on the drawings.

E. Do not splice conductors in enclosure. Where required, install junction box or wireway adjacent to disconnect and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the WIRES AND CABLES section of the specifications and do not exceed.

F. Conductors not terminating in disconnect shall not extend through or enter disconnect enclosure.

G. Install push-in knock-out closure plugs in any unused knock-out openings (NEMA1). Provide Hoffman Hole-Seal in NEMA 4X switches.

H. Identification

1. Disconnect switches shall be identified.
2. Refer to the ELECTRICAL IDENTIFICATION section of the specifications for identification requirements.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

END OF SECTION

DIVISION 26 – ELECTRICAL

262913 – MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of the installation of motor controllers for all integral or fractional horsepower motors not controlled by magnetic starters installed in motor control center or by magnetic starters provided as an integral component of a specific piece of equipment. Provide all material under this section of the specifications.

1.03 QUALITY ASSURANCE

A. ANSI/NEMA Standards Publication ICS 1 - General Standards for Industrial Control and Systems.

B. ANSI/NEMA Standards Publication ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. UL 508 Standards for Industrial Control Devices, Controllers and Assemblies - Industrial Control Equipment.

1.04 ACCEPTABLE MANUFACTURERS

A. The products of General Electric, Square D, or Eaton conforming to these specifications are acceptable.

PART 2- PRODUCTS

2.01 MAGNETIC STARTERS

A. Magnetic starters shall be across-the-line circuit breaker combination type non-fusible disconnect combination type when remotely located from circuit breaker in panel or switchboard; otherwise magnetic starters shall be non-combination type. Where circuit breaker type are used, UL interrupting rating of circuit breaker shall not be less than the rating of the overcurrent device immediately upstream.

B. Magnetic starters shall be NEMA size one unless other size is shown on the drawings or unless larger size is required by actual motor controlled. Enclosures shall be NEMA one unless otherwise shown on the drawings or specified in this section of the specifications. Starters shall be for operation at the voltage and phase arrangement indicated.

C. Each magnetic starter shall have overload relays in each phase leg. Control voltage shall be 120 volts provided from a control power transformer built into starter. Provide fuse for control coil. Provide Hand-Off-Automatic switch, in cover of starter unless otherwise indicated on the drawings. Interlocks shall be provided to provide control sequence indicated on the drawings. Interlock contact shall be provided circuit breaker of combination magnetic starters to disconnect control circuit when circuit breaker is in "off" position.

D. Operating handle of disconnect device in combination starters shall be interlocked with door to prevent opening door when starter is energized; however an inconspicuous means shall be provided to defeat this interlock. Operating handle must have provisions for not less than two padlocks.

E. Overload relay shall be solid state type and shall be selected from actual nameplate rating of motor furnished.

2.02 MANUAL MOTOR STARTERS

A. Manual motor starter shall be manually operated, trip free switching device with motor running protection overload elements in each ungrounded conductor of the motor circuit. Overload protection shall be melting alloy or bi-metallic manual reset type.

B. Manual starters installed in finished spaces shall be provided in flush mounted enclosures. Those exposed to the weather shall be provided with NEMA 4X enclosure. All other enclosures shall be NEMA one type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Secure wall mounted magnetic starters to mounting surface with wood screws on wood, toggle bolts on hollow masonry, and lead shields on solid masonry.

B. Manual motor starters shall be provided for all fractional horsepower, single phase motors rated 1/6 HP or larger.

C. Overload element shall be selected in accordance with full load nameplate rating of motor actually served. A heater schedule shall be provided on inside cover all motor starters.

3.02 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.03 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specifiction.

END OF SECTION

DIVISION 26 – ELECTRICAL

263213 – ENGINE DRIVEN EMERGENCY POWER SUPPLY SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of the installation of the complete Engine Driven Emergency Power Supply System. All materials and devices which are an integral part of this system shall be provided under this section of the specifications.

B. Definition: The Emergency Power Supply System (EPSS) shall consist of one or more engine driven generator sets, each of which contains an engine directly coupled to an electric generator, together with the necessary switchgear, controls, accessories, transfer devices, and fuel supply to provide electric power for the duration of any failure of the normal power supply.

1. Automatic Transfer Switch (ATS): An automatic transfer switch is self-acting equipment for transferring one or more load conductor connections from one power source to another.

C. For this project the contractor shall provide one 450kW/563kVA diesel engine-generator set with permanent magnet excitation, a Level 2 sound-attenuated 150mph wind rated aluminum housing, 24 hr fuel capacity double wall sub-base tank, a 1200A 4-pole isolation/bypass automatic transfer switch with intermediate position.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this specification by reference.

1. National Fire Protection Association (NFPA):
   a. NFPA-37 Combustion Engines
   b. NFPA-70 National Electrical Code
   c. NFPA-110 Emergency and Stand-By Power Systems
2. Diesel Engine Manufacturers Association (DEMA) Standard: Standard Practices for low and medium speed stationary diesel and gas engines.
3. Electrical Generating Systems Association (EGSA) Standards:
   a. EGSA CEP2 Codes for Emergency Power by States and Major Cities

b. EGSA GTD3 Glossary of Standard Industry Terminology and Definitions
c. EGSA ECB1 Performance Standard for Engine Cranking Batteries
d. EGSA TSS1 Performance Standard for Transfer Switches for use with Engine Generator Sets
e. EGSA BCES1 Performance Standard for Battery Chargers
f. EGSA ICAE1 Performance Standard for Electric Generator Set Instrument Control and Auxiliary Equipment

4. Institute of Electrical and Electronics Engineers (IEEE) Standards:
   a. IEEE 446 IEEE Recommended Practices for Emergency and Standby Power Systems
   b. IEEE 472 Voltage Surge Withstand Capabilities
5. National Electric Manufacturers Association (NEMA) Standards:
   a. MG-1 Motors and Generators
   b. ICS1-109 Test and Test Procedures for Automatic Transfer Switches
   c. ICS2-447 A.C. Automatic Transfer Switch
6. Underwriters Laboratories Inc. (UL) Publications:
   a. UL 1008 Automatic and Non-Automatic Transfer Switches
7. American National Standards Institute (ANSI):
   a. C37.90a Voltage Surge Withstand Capability

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:

1. Engine Driven Generator Sets:
   a. Cummins
   b. Caterpillar
   c. MTU
2. Transfer Switches:
   a. Cummins BTPC Series
   b. ASCO 7000 Series
3. Sub-Base Fuel Tanks:
   a. Pryco
   b. Simplex

C. Equipment Dimensions:

1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where equipment of acceptable manufacturers listed exceeds the maximum dimensions, products of such manufacturers shall not be acceptable.

D. Coordination:

1. Review shop drawings submitted under this and other sections, as well as other divisions, to insure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other

sections of the specifications, and electrical equipment to insure access and to insure clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES Section for required procedures.

B. Manufacturer's Product Data:

1. Submit material specifications and installations data for products specified under Part 2 - Products to include:
   a. Engine driven generator sets
   b. Transfer switches
   c. Sub-base fuel tanks

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings. Submittals containing less than the information listed below will be rejected.

1. Shop drawings for the engine driven generator sets shall contain not less than the information listed as follows:
   a. Certification that the engine driven generator set(s) furnished will serve electrical loads indicated including motor starting loads with type(s) of starting indicated.
   b. Continuous and stand-by rating of engine driven generator set(s) including voltage and phase.
   c. Frequency and voltage regulation with maximum instantaneous voltage dip and time of recovery to stable operation.
   d. Output voltage adjustment range in percentage of rated plant voltage.
   e. Alternator type and method of connection to prime mover.
   f. Components contained in alternator instrument panel.
   g. Rating of engine at operating speed, engine cycle and number of cylinders.
   h. Type of engine lubrication system and verification of components specified.
   i. Type of engine governor.
   j. Components contained in engine instrument panel.
   k. Fuel consumption at rated load.
   l. Starting batteries including ampere hour rating.
   m. Verification that all accessories specified are to be provided. This includes tank with capacity indicated, cold weather starting aid with rating and voltage indicated, exhaust system with muffler type indicated, and outdoor housing (where applicable) with verification of space available within housing for batteries.
   n. Line and machinery constants of the generator furnished.
   o. Terminal board connection diagram where reconnectable generators are specified.

2. Shop drawings for the transfer switch shall contain not less than the information listed as follows:
   a. List of accessories contained in the control panel.
   b. Withstand rating in RMS symmetrical amperes.

D. Quality and Service:

1. All materials and parts of the EPSS shall be new and unused. Each component shall be of current manufacture from a firm regularly engaged in the production of such equipment. Units and components offered under these specifications shall be covered by the manufacturer's parts and labor warranty for a minimum of five years from date of Owner acceptance of the project on a new machine, a copy of which shall be included in the shop drawings submittal.
2. Submittals will be accepted only on engine driven generator sets and transfer switches which can be properly maintained and serviced without requiring the Owner to stock spare parts or wait longer than twenty-four hours for service. Submittals shall include the nearest location of permanent parts outlet from which parts may be obtained and written assurance that trained service personnel will be available on twenty-four hour's notice. Units with service centers more than 50 miles from project site will not be accepted.

E. Record Drawings

1. Include in each set three sets of operating, maintenance, and parts manuals covering all components for the EPSS. Each supplier shall provide instructions to the Owner in operation and maintenance of his equipment, both in written form and with on-site personnel for a minimum of eight hours.

PART 2 - PRODUCTS

2.01 ENGINE DRIVEN EMERGENCY POWER SUPPLY (EPS)

A. Engine

1. The engine driven emergency power supply (EPS) shall be an internal combustion diesel driven prime mover. The generator set shall have the following characteristics:
   a. 450 KW Capacity
   b. 563 KVA Capacity
   c. 480Y/277V
   d. 60Hz
   e. 0.8 Power Factor
   f. 3 Phase
   g. 4-Wire
2. Maximum one-step load at 0.8 P.F. is 106.24 kW (step 1). The load to be served by this generator set consists of 132.8kVA non-inductive load plus 240 total motor horsepower. The motors shall be started as shown in the following table:

Starting Sequence				
	Initial Load	132.8KVA		
Step	Load	Quantity/HP	Code Letter	Starting
1	Pre-Areation Blowers	4/15	G	VFD
	MBR Blowers	4/15	G	VFD
2	Digester Blowers	2/15	G	VFD
	WAS Recycle Pumps	4/1.5	G	VFD
3	WAS Centrifuge Pumps	4/5	G	VFD
	Internal Recycle Pumps	8/4.7	G	VFD
4	MBR Permeate Pumps	4/5	G	VFD
	Anoxic Basin Mixer	4/1.7	G	VFD
	Odor Control (Plant)	1/6.5	G	VFD
5	Bongo Screen	9.8KVA	G	VFD
	Plant Drain PS	29.4KVA	G	VFD

Coordinate with SCADA and Ovivo to provide load starting to match steps shown.

3. The rated net horsepower of the engine at the generator synchronous speed, with all accessories, shall not be less than that required to product the KW specified in paragraph 1 above. The horsepower rating shall take into account generator efficiency and all accessory losses such as fans, battery charger, etc. The generator set shall be capable of producing the specified KW (without overload) for the duration of the power outage, under the following ambient conditions:
   a. Altitude: 50 feet above mean sea level.
   b. Air temperature at engine intake: 104 degrees F.
   c. Humidity Range: 5 - 95%.
4. Included with the shop drawing submittal shall be the manufacturer's estimate of supply fuel and oil consumption for the engine. The engine shall have an oil filter with replaceable elements, and a lube oil cooler.
5. The engine shall be equipped with a suitable governor (engine speed control) to maintain frequency within limit specified below by controlling engine and generator speed. Manufacturer shall indicate in submittal data whether mechanical, hydraulic, electrical, or hybrid governors are provided.
   a. Type: Droop - 5% maximum
   b. Stability: 1/2% maximum steady state frequency variation at any constant load from no load to full load.
   c. Regulation: 5% maximum frequency deviation between no-load steady state and full load steady state.
   d. Transient: 2 seconds maximum recovery time for maximum motor start.
6. The engine shall be electric start, provided with a solenoid energized motor with either positive engagement or clutch drive to the engine.

7. The engine starting batteries shall be sealed lead-acid recombination type. Batteries shall be rack mounted inside the weatherproof plant housing to minimize the distance from the batteries to the starter. Provide battery straps and battery heaters.
8. A float type battery charger, compatible with the batteries selected, shall be furnished at the engine which shall maintain the starting batteries at full charge. The charging system shall permit charging from either the normal or the emergency power source.
9. It shall have an equalize rate and a float rate charging system. An ammeter and voltmeter shall indicate the charge rate and the circuit shall be protected by either fuses or circuit breakers. The charger or charging circuit shall be so designed that it will not be damaged during the engine cranking cycle, for example, by a current limiting charger or a crank disconnect relay. It shall also be capable of recharging a discharged battery in 12 hours while carrying normal loads. The charger shall be equipped with alarm relays as required for remote annunciation equipment.
10. The engine shall be liquid cooled. The type of liquid cooling system shall be unit mounted radiator - consideration shall be given for air temperature rise across the engine in addition to ambient. Minimum capacity shall be rated for 100°F. minimum engine ambient temperature plus air temperature rise across the engine.
    a. Provide an electric heater, thermostatically controlled, in the engine coolant system as a cold weather starting aid. Heater shall be for operation on 120 or 240 volt single phase A.C. and shall be permanently connected to a circuit from the electrical system. Heater shall maintain 70°F. to 90°F.
    b. Provide isolation valves or quick connect couplings for jacket water heater.
11. Air Supply/Exhaust System
    a. Cleaner: An air cleaner and silencer shall be furnished, located and mounted as recommended by the engine manufacturer.
    b. Exhaust: An exhaust system of suitable size, configuration, and material in accordance with engine manufacturer's recommendations shall connect the exhaust outlet of the engine to a silencer. The type of silencer shall meet the requirements of engine manufacturers and shall be critical. The silencer shall be located inside of the outdoor enclosure.
    c. The exhaust system including silencer shall be of such size that back pressure on the system will not exceed the back pressure permitted by the engine manufacturer's recommendation. A flexible connection shall be mounted at the engine exhaust outlet and the discharge end shall be protected against entry of precipitation. Provide vertical discharge with rain cap. Piping and silencer within reach of personnel or with 8'-0" of finished floor or grade shall be protected by screening and shall be insulated with two inches of calcium silicate insulation with aluminum jacket. All exhaust piping shall be gas tight.

12. The engine instrument panel shall be mounted at the engine and shall contain the following:
    a. Oil pressure gauge to indicate lubricating oil pressure.
    b. Temperature gauge to indicate cooling medium temperature.
    c. Hour meter to indicate total actual running time.
    d. Battery charging meter to indicate satisfactory performance of battery charging means.
    e. Other instruments as recommended by the manufacturer for proper maintenance.
    f. Manual stop/start controls: All instruments, controls, and indicating lights shall be properly identified. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified.

B. Generator

1. The generator shall be an engine-driven single or two bearings type, synchronous, brushless, conforming to applicable standards. It shall be connected to the engine flywheel by means of a flexible type coupling for single bearing generators and elastic coupling for two bearing generators.
2. The generator shall be rated for 40°C. ambient. Class of insulation shall be NEMA Class F. The voltage regulation shall be plus or minus 2% from no load to full load with plus or minus 5% speed change and a 15°C. rise in ambient. The generator voltage dip from no load to full load shall not exceed 16%.
3. The generator shall be capable of sustaining at least 250% of rated current for at least ten (10) seconds under a three phase symmetrical short by inherent design or by the addition of an optional current boost system. A resettable line sensing circuit breaker shall be furnished which protects the generator from damage due to its own high current capability. This breaker shall not trip within the ten seconds specified above to allow selective tripping of downstream fuses or circuit breakers under a fault condition.
4. Provide 120 volt condensation heater in generator windings.
5. The generator shall be the Permanent Magnet type generator.

C. Voltage Regulation

1. The generator shall be equipped with a volts-per-hertz type voltage regulator to maintain voltage within limits specified below:
    a. Stability: 2% maximum voltage variation at any constant load from no load to full load.
    b. Regulation: 4% maximum voltage deviation between no load steady state and full load steady state.
    c. Transient: 20% voltage dip or overshoot on one-step application or removal of 0.8 power factor full load.

D. Generator full main line circuit breaker.

1. A main line circuit breaker shall be supplied to protect the generator and controls from overloads and/or short circuits in the load. It shall be rated as indicated on the drawings. Breakers shall comply with UL 489 and NEMA AB-3.

E. Start and Stop Controls

1. Automatic starting and stopping controls shall be furnished to start the engine automatically when the normal electrical power fails or falls below specific limits and to stop the engine automatically after the normal power supply resumes. The signal for starting or stopping the engine shall be sensed through an auxiliary contact in the automatic transfer switch. The controls shall be capable of operating at 50% of normal DC system supplied voltage.
2. The cranking cycle shall be initiated by manual start, loss of normal power at any transfer switch, clock exerciser, or the manually operated test switch at each ATS.
3. Crank control and the time delay relays shall provide a minimum of 4 crank attempts of at least 7 seconds each, separated by appropriate rest periods. A sensing device shall automatically disconnect the starting circuit when the engine has started. If the engine has not started at the completion of the starting program, the overcrank signal shall indicate. The engine starting controls shall be locked out and no further starting attempts shall take place until the overcranking device has been manually reset.
4. A selector switch shall be incorporated in the automatic engine start and stop controls. It shall include an "off" position that prevents manual or automatic starting of the engine; a "manual" position that permits the engine to be started manually by the pushbutton on the control cabinet and run unloaded; an "automatic" position that readies the system for automatic start or stop on demand or the automatic load transfer switches or of the programmed exerciser.
5. A remote manual stop station similar to a break-glass station shall be provided on the automatic transfer switch enclosure exterior and shall be tied into the engine controls to stop the engine when activated. Provide laminated plastic label with 1/4" minimum engraved letters to read "EMERGENCY GENERATOR SHUTDOWN". Background to be red and core to be white.

F. Instrumentation

1. Local engine control and safety panel shall be provided, containing the following:
   a. Automatic remote start capability.
   b. "Manual-Off-Auto" switch.
   c. Controls to shut down and lock out the prime mover under the following conditions: failure to start after specified cranking time, overspeed, low lubricating oil pressure, high engine temperature, or operation of remote manual stop station.
   d. Battery powered individual alarm indication to annunciate visually at the control and safety panel the occurrence of any condition itemized below;

contacts or circuits for a common audible alarm signaling locally the occurrence of any itemized conditions listed below. Test switch shall be provided to test the operation of all lamps.

1) Indicator Function, Level 1 (At Battery Voltage):

	Control Panel Mounted Visual Indication	Shutdown of EPS	Audible
a) Overcrank	X	X	X
b) Low Water Temp. < 70°F (21°C)	X		X
c) High Engine Temp. Pre-alarm	X		X
d) High Engine Temp.	X	X	X
e) Low Lube Oil Pressure Pre-alarm	X		X
f) Low Lube Oil Pressure	X	X	X
g) Overspeed	X	X	X
h) Low Fuel Main Tank	X		X
i) EPS Supplying Load	X		
j) Control Switch Not In Auto Pos.	X		X
k) Battery Charger Malfunctioning	X		X
l) Low Voltage in Battery	X		X
m) Lamp Test	X		X
n) Contacts for Local & Remote			
o) Common Alarm	X		X
p) Audible Alarm Silencing Switch			
q) Fuel in Containment Basin	X		X
r) Remote Emergency Stop	X	X	X

2) Controls to shutdown the prime mover upon removal of initiating signal or manual emergency shutdown.
3) A.C. voltmeter with selector switch off position and positions for phase to phase and phase to neutral.
4) A.C. ammeter with selector switch with positions for each phase.
5) Frequency meter -- digital electronic type.

6) Voltage adjusting rheostat to allow plus or minus 5% voltage adjustment.
7) Manual reset circuit breaker.
8) Water temperature gauge.
9) Manual stop/start control.
10) Elapsed time meter.
11) Panel lights.
12) Indicator lights for signals from engine instrument panel.
13) Light to indicate switch has been left in the "off" position.

2. All instruments, controls, and indicating lights shall be properly identified. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified. All instrumentation must be isolated from engine generator set vibration.
3. Provide ‘alarm’ and ‘run’ contacts for connection to SCADA.

G. Enclosures and Connections:

1. All electrical enclosures, i.e, terminal cabinets, wireways, circuit breaker enclosures, etc., shall be of adequate size to provide minimum bending radius as required by the NEC for the size conductor actually terminated within or passing through the enclosure.
2. All factory provided enclosures shall have gasketing and finish appropriate for the environment in which the unit is to be mounted. All wiring, wiring harness, etc., shall be protected from the elements, such as direct sunlight, moisture, etc. or shall be UL listed for direct exposure to the applicable elements. Include written documentation of the above with the shop drawing submittal.

H. Provide flexible fuel connections at supply at return piping. Flexible hoses shall be steel reinforced type. Provide solenoid valve in series with gate valve in supply line. Solenoid valve shall be powered from generator batteries and shall be open only when generator is running.

I. Provide service lights within the generator weather enclosure.

2.02 TRANSFER SWITCH(ES)

A. Transfer switch(es) shall be rated at not less than as indicated on the drawings at rated voltage. Transfer switch(es) shall be rated and marked for total system load.

B. Transfer switch(es) serving three phase four wire loads shall be four pole. Provide timed transition type switch with intermediate position.

C. Transfer switch(es) shall be the automatic type with power contact assemblies. Transfer switches shall be U.L. listed and labeled 1008.

D. Transfer switch(es) shall be floor mounted in a NEMA 1 painted steel enclosure. Enclosure shall have hinged door with three point latching and provisions for pad locking.

E. Operation shall be inherently double-throw whereby all contacts move simultaneously. Electrical spacing shall be equal to or exceed those listed in Table 15.1 of UL-1008. Only those main contact structures specifically designed for transfer switch service shall be acceptable. An overload or short circuit shall not cause the switch to go to a neutral position. A manual operating handle shall be provided. All main contacts shall be silver alloy type protected by arc quenchers and, for switches rated 600 amps and larger, by arching contacts. Operating transfer time shall be 1/15 second or less on switches rated below 600 amps. The transfer sequence shall be "Open Transition".

F. All switch and contacts, coils, springs and control elements shall be removable from the front of the transfer switch without removal of the switch panel from the enclosure and without disconnecting power conductors or drive linkages. Control and sensing relays shall be continuous duty industrial type with minimum contact rating of ten amps.

G. Transfer switch shall be rated to withstand in RMS symmetrical amperes not less than the available symmetrical RMS amperes when protected by the circuit protective device on the line side of the transfer switch. Withstand rating of switch shall be based on switch contacts not welding under fault conditions.

H. Transfer switches shall be U.L. listed and labeled for service entrance. Transfer switches shall be furnished with an insulated neutral, bonding jumper and a ground bar bolted to the transfer switch enclosure.

I. The control panel for each automatic transfer switch shall contain the following accessories and Features.

1. ATS Control Panel (Cummins M018 or equal)
    a. The automatic transfer switch(es) shall provide a control panel mounted into the front of the switch. This control panel shall display source condition information including:
    b. AC voltage for each phase of normal and emergency source. All three phases shall be displayed on a single screen for viewing of voltage balance and on 4-wire systems, line to neutral voltage shall be displayed for each phase.
    c. Frequency of each source.
    d. Display source status including indication whether source is/is not connected.
2. The ATS control panel shall allow the operator to make adjustments to and/or set nominal voltage and frequency of the ATS, frequency sensor operation set points, time clock functions, and load sequence functions. The operator may

also enable/disable ATS functions, set up exercise and load test operation conditions, normal system time delays for transfer, time delay to start, stop, transfer and retransfer. These parameters may only be accessed following password input from the authorized operator.

3. The display shall include real time clock data, including date, time (HH:MM:SS) and log total operating hours for the control system.
4. The display shall include a service history for the ATS and a fault history on the ATS.
5. Adjustable 0.5 to 6 second time delay on starting of EPS to override momentary power dips and interruptions of the normal services. Time delay shall be factory set at 1 second.
6. Time delay on transfer to emergency adjustable from 0 to 60 seconds, factory set at 0 seconds.
7. Test switch on enclosure door to simulate failure of the normal power source. ATS shall transfer load to the EPS.
8. Push button to bypass time delay on re-transfer to normal.
9. Close differential voltage sensing shall be provided on all phases of the normal power supply. The pickup voltage shall be adjustable from 85% to 100% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value. The transfer to emergency will be initiated upon reduction of normal source to 85% of nominal voltage and re-transfer to normal shall occur when normal source restores to 95% of nominals.
10. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 100% of nominal. Pickup frequency shall be adjustable from 90% to 100% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal and frequency is 95% or more of nominal.
11. A time delay on re-transfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 25 minutes and factory set at 15 minutes.
12. An unloaded running time delay for emergency generator cool-down, factory set at 5 minutes.
13. Provide adjustable timed intermediate position in both directions.
14. Pilot light for indicating switch in normal position (include fuses and auxiliary contact).
15. Pilot light for indicating switch in emergency position (include fuses and auxiliary contact).
16. An exerciser for exercising standby power plant on a weekly basis shall be provided in the transfer switch. Exerciser shall be set to exercise standby plant for one half hour per week under load. Time of plant exercise shall be set in field. Exerciser timer shall have reserve power back-up, either by battery or spring-wound clock, to ride through power outages to the switch.

17. Auxiliary contact (gold plated) which closes when normal source fails. (Closed after override delay of 0.5 to 6 seconds).
18. Auxiliary contact (gold plated) which opens when normal source fails. (Opens after override delay of 0.5 to 6 seconds).
19. Auxiliary contacts on same shaft as main contacts (closed on normal.)
20. Auxiliary contacts on same shaft as main contacts (closed on emergency).

J. Bypass Isolation Switch

1. The bypass isolation switch(es) shall have the same specification requirements as the automatic transfer switch portion of this specification except as described below:
   a. The automatic transfer and bypass-isolation switch shall be provided to manually permit convenient electrical bypass and isolation of the automatic transfer switch. Bypass of the load to either the normal or emergency power source with complete isolation of the ATS shall be possible regardless of the status of the ATS. The bypass-isolation switch shall permit proper operation by one person through the movement of a maximum of two handles at a common dead front panel. The entire system shall consist of two elements: The automatic transfer switch and the bypass-isolation switch furnished completely factory interconnected and tested.
   b. The operating speed of the bypass switch contacts shall be the same as the automatic transfer switch and independent of the speed of operation of the bypass handle.
   c. The automatic transfer and bypass-isolation switch shall be the product of one manufacturer and be completely factory interconnected and tested so that only the service and load connections to the bypass-isolation switch are required for field installation. All interconnections between the transfer switch, bypass switch and isolation switch shall be by silver-plated copper bus bar. A visual position indicator shall be provided to indicate bypass-isolation switch positions, and availability of normal and emergency sources. A prominent and detailed instruction plate shall be furnished for convenient operation.
   d. The automatic transfer and bypass-isolation switch shall provide manual bypass of the load and isolation of all service and load terminals of the automatic transfer switch to permit periodic testing, maintenance, and service of the automatic transfer switch.
   e. The bypass-isolation switch shall be capable of bypassing the load to either source. Provisions shall be made to assure continuity of auxiliary circuits necessary for the proper operation of the system.
   f. The isolation handle shall provide for automatic operation, testing, or removal of the automatic transfer switch. The Test position shall permit electrical testing of the automatic transfer switch without disturbing the load. The open position shall completely isolate the transfer switch from both lines and load without actual removal of the line or load conductors, and allow its removal for inspection, adjustment and maintenance. The

transfer switch shall be arranged for drawout operation to facilitate its removal. Also, while in the Test or Open positions, the bypass switch shall function as a manual transfer switch to allow load transfer to either source of power regardless of the position or condition of the transfer switch, including the condition when the automatic transfer switch is removed, and without reconnecting the load terminals of the automatic transfer switch.

g. The isolation bypass switch cable terminations shall not require rear access. Only side and front termination permitted.

2.03 FUEL SUPPLY

A. A double wall fuel storage tank with sufficient fuel capacity to allow the EPS to operate continuously at full rated load for 24 hours (600 gallon min.) shall be located in the skids below the generator set, and shall be complete with all piping and fittings connected. No galvanized material shall be used in the tank or fueling system. The tanks shall be vented to atmosphere. A fuel level gauge shall be located as indicated on the drawings. The system shall be supplied to deliver an adequate amount of fuel to the engine from the storage tank. Pipe sizes shall be no smaller than the minimum recommended by the engine manufacturer to avoid fuel flow restriction. The engine supply and return line shall be equipped with a length of flexible fuel lines, unions, and gate valves. No copper lines are acceptable.

B. The fuel tank shall not exceed 18" high but may extend beyond the generator length and width.

C. Should the fuel tank exceed 18", the contractor shall provide a work platform around the sides and controls end of the generator, extending a minimum of three (3) feet from the generator, but in no case shall the platform be narrower than the length of the service doors so that the generator remains fully accessible for servicing. The platform shall be provided with a handrail, three (3) feet high. The platform deck shall be equal in elevation to the top of the fuel tank and shall be supported by the concrete pad of the generator. The concrete pad shall be extended to fully support the platform and generator. The platform shall be fabricated from welded aluminum tubing, the deck shall be heavy duty aluminum grating, the platform shall be provided with aluminum steps as required to access the working deck elevation.

D. Provide a set of normally open contacts in fuel level indicating system of fuel tank. Interconnect with remote low fuel alarm specified earlier in this section.

E. Provide 'Fuel in Containment' contact in basin and Leak Detection System.

F. Provide 300 gallons of fuel at start of load bank testing.

PART 3 - EXECUTION

3.01 EPS INSTALLATION

A. The plant shall be anchored to a concrete base whose overall dimensions shall exceed the outside dimensions of the plant base by 12" in each direction. Base depth shall be 12". Refer to the detail on the plans

B. Provide a laminated sign at the service entrance equipment indicating type and location of on-site emergency power sources.

C. For exterior installations, the EPS shall be provided in outdoor, weatherproof housing with removable panels for access to equipment. The starting batteries shall be rack mounted within the housing.

D. The enclosure shall be constructed of pre-painted aluminum, panels and posts shall be 0.125” thick (ASTM B209, 5052 H32). The housing shall be wind rated to 150 mph per ASCE 7-98 exposure D, category 1 importance factor. The enclosure shall be required to provide sound attenuation, level 2.

E. Provide fluorescent service lights and weather proof switch within the housing. Connect the light to the battery charger 120 volt circuit.

F. Extend 120 volt emergency power circuits for chargers and cold weather starting aids from the control panel wiring system.

G. Provide 300 gallons of fuel before testing.

3.02 TRANSFER SWITCH INSTALLATION

A. Locate transfer switch(es) to provide working clearance and full accessibility as required by the National Electrical Code.

B. Lace and group conductors installed in transfer switch with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug. Conductors shall be installed such that no stresses are transferred to terminal lugs.

C. Mounting and Support

1. Mounting
    a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. Transfer switches 400 amps and larger shall be secured by a minimum of eight (8) devices. A 1.5 inch minimum diameter round washer shall be used between head of screw or bolt and enclosure.

b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
c. Attach enclosure directly to the wall.
d. Refer to the detail on the drawings for frame installation and construction information.
e. Do not splice conductors in enclosure. Where required, install junction box or wireway adjacent to transfer switch and splice or tap conductors in box.
f. Conductors not terminating in transfer switch shall not extend through or enter transfer switch enclosure.
g. Install push-in knock-out closure plugs in any unused knock-out openings.
h. Free standing transfer switch(es) shall be installed on a four inch high concrete pad, with horizontal base dimension exceeding base dimension of switch by three inches.
i. Cleaning and Adjustment
    1) After completion, clean the interior and exterior of dirt, paint and construction debris.
    2) Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.03 TESTING

A. Submit verification letter to Engineer indicating successful completion of sequence of operations testing and certification that all functions are operational. Letter to request load testing approval and schedule of proposed test. Prior to load test, written approval must be provided by Engineer. Representatives of the generator and transfer switch shall be present. The local authority having jurisdiction shall be given advance notification of the time of the final test in order that he may witness the tests.

B. A failure of any test or any component during a test will require a complete retest program at no additional cost to the Owner.

C. Provide all fuel, lubricants, and other consumables for testing.

D. An on-site acceptance test shall be conducted as a final approval test for all Emergency Power Supply Systems.

1. The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating.
2. Test Results. The EPSS shall perform within the limits specified in the standard NFPA-110, Level 1.

3.04 O&M MANUALS

A. At least three sets of an instruction manual(s) for all major components of the EPS shall be supplied by the Manufacturer(s) of the EPS and shall contain:

1. A detailed explanation of the operation of the system.

2. Instruction for routine maintenance.
3. Detailed instructions for repair of the EPS and other major components of the EPS.
4. Pictorial parts list and part numbers.
5. Pictorial and schematic electrical drawings of wiring systems, including operation and safety devices, control panels, instrumentation and annunciators.

END OF SECTION

DIVISION 26 – ELECTRICAL

266500 – ELECTRICAL EQUIPMENT ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consist of the start-up testing and inspection of the electrical equipment designated within. All labor and testing equipment which is required shall be provided under this section of the specifications.

1.03 GENERAL

A. The Contractor shall perform the tests as outlined below to insure system acceptance.

B. When the tests and inspections have been completed, a label shall be attached to all devices tested. The label shall provide the name of the testing company, the date the tests were completed, and the initials of the licensed electrical contractor who performed the tests.

C. The tests shall insure that the equipment is operational and functioning within industry standards and manufacturer's tolerances. Forward all test reports to the Engineer at least two weeks prior to the project final inspection for review. Reports shall be bound as required by Division 1 of this specification.

1.04 QUALITY ASSURANCE

A. The testing and inspection shall comply with all applicable sections of the following codes and standards:

1. American National Standards Institute - ANSI
2. American Society for Testing and Materials - ASTM
3. Association of Edison Illuminating Companies - AEIC
4. Institute of Electrical and Electronics Engineers - IEEE
5. Insulated Power Cable Engineers Association - IPCEA
6. International Electrical Testing Association - NETA Acceptance Testing Specifications
7. National Electrical Code - NEC

8. National Electrical Manufacturers Association - NEMA
9. National Fire Protection Association - NFPA
10. State and Local Codes and Ordinances

B. The inspection and testing shall comply with the project plans and specifications as well as with the manufacturer's drawings, instruction manuals, and other applicable data for the apparatus tested.

1.05 DIVISION OF RESPONSIBILITY

A. The contractor shall perform all tests.

B. The contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. The contractor is responsible for obtaining and approving a short-circuit analysis and coordination study prepared by the switchgear manufacturer.

E. The testing firm shall notify the Engineer prior to commencement of any testing.

F. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported to the Engineer.

G. The electrical contractor shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

1.06 SAFETY AND PRECAUTIONS

A. Safety practices shall comply with applicable state and local safety orders as well as with the Occupational Safety and Health Act of 1970 (OSHA). Compliance with the National Fire Protection Association standard NFPA 70E and the Accident Prevention Manual for Industrial Operations of the National Safety Council shall be observed.

B. Tests shall only be performed on apparatus which is de-energized. The testing company's lead test engineer for the project shall be a designated safety representative and shall supervise testing observations and safety requirements. Work shall not proceed until he has determined that it is safe to do so.

C. Power circuits shall have conductors shorted to ground by a hotline grounded device approved for the purpose. Warning signs and protective barriers shall be provided as necessary to conduct the tests safely.

1.07 REPORTS

A. The test report shall include the following sections:

1. Scope of testing
2. Equipment tested
3. Description of test
4. Test results
5. Conclusions and recommendations
6. Appendix, including test forms

B. Each piece of equipment shall be recorded on a data sheet listing the condition of the equipment as found and as left. Included shall be recommendations for any necessary repair and/or replacement parts. The data sheets shall indicate the name of the engineer who tested the equipment and the date of the test completion.

C. Record copies of the completed test report shall be submitted no more than 30 days after completion of the testing and inspection.

1.08 TEST EQUIPMENT

A. All test equipment shall be in good mechanical and electrical condition. All field instruments shall have been calibrated within six months of the testing date, and dated calibration labels shall be visible on the testing equipment. Submit calibration certification in the final report.

PART 2 – PRODUCTS

2.01 MATERIALS

A. All materials are specified under other sections of this specification. All testing equipment required shall be provided under this section of the specifications.

PART 3 - EXECUTION

3.01 EQUIPMENT TO BE TESTED

A. The following equipment shall be tested in accordance with the scopes of work which follow. The party responsible is identified in accordance with the following key: C = Contractor; M = Manufacturer.

1. Dry Type Transformers - C
2. Low Voltage Switchgear and Switchboards - C
3. Molded Case Circuit Breakers - C
4. Motor Control Centers and Motor Controllers – M
5. Fire Alarm System – C
6. Automatic Transfer Switches - M

7. Emergency Power Supply-Engine Driven - M
8. Lighting Control System - C
9. Grounding System - C
10. Cables, Low Voltage, 600 Volts Maximum - C
11. Ground Fault Systems - M
12. Surge Arrestors - C

3.02 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection

1. With case covers removed, inspect transformer core and coil assembly and enclosure interior. Cloth wipe and/or brush major insulating surfaces.
2. Check primary, secondary, and ground connections.
3. Check tap connections and tap changer.
4. Inspect all bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect insulators, spacers, and windings.
6. Inspect for adequate electrical clearance.
7. Check base or support insulators, including vibration isolation supports.
8. Check accessory devices for condition and proper operation.
9. Verify that the transformers have been provided with adequate spacing for ventilation.

B. Electrical Tests

1. Insulation Resistance Test: Megger transformer windings high to low and ground, low to high and ground, and high and low to ground.
2. Where auxiliary cooling has been provided, verify proper operation of such equipment.
3. Include measured secondary voltage (line-to-line and line-to-ground) for each transformer in the test report. Verify that the taps on all transformers with primary voltages above 600 volts are set to deliver voltage indicated in the Contract Documents with the system in full operation. Secondary voltage readings, at each transformer, phase to phase neutral, and phase load readings shall be recorded and tap positions of transformer taps noted. This test shall be conducted with a calibrated voltmeter.
4. Each ground rod installation shall be tested after all connections to ground rods are made before grounding conductor connection is made to the transformer. Ground rod installations shall be tested by "fall of potential" measuring method using ground resistance test meter and two auxiliary electrodes driven into the earth, interconnected through the meter with the ground rod installation being tested.
5. Placement of auxiliary electrodes shall be in accordance with operating instructions of test meter, but in no case shall auxiliary current electrodes be placed within 70' of the grounding system being tested. Test data shall indicate

placement of auxiliary electrodes with respect to systems being tested, date readings were taken and lowest resistance recorded.

3.03 LOW VOLTAGE SWITCHGEAR AND SWITCHBOARDS

A. Visual and Mechanical Inspection

1. Verify that the contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign materials.
2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check for proper travel and alignment of any drawout or plug-in circuit breakers.
4. Check breaker connections to bus.
5. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
6. Inspect for missing or loose hardware or accessories.
7. Inspect ground bus connections.
8. Operate key and door interlock devices to assure proper operation.

B. Electrical Tests

1. Insulation Resistance Test: Megger main secondary bus and feeder circuits phase-to-phase and phase-to-ground.
2. Energize any space heater circuits to insure proper operations.

C. Check phase rotation with a Biddle phase rotation meter.

D. Instruments and Meter Tests

1. Inspect panel mounted instruments and meters. Clean and check for calibration accuracy. Make minor adjustments as necessary.

3.04 MOLDED CASE CIRCUIT BREAKERS

A. Visual and Mechanical Inspection

1. Inspect cover and case, and check for broken or loose terminals.
2. Operate breaker to check operation.

B. Electrical Tests (400 ampere frame and larger)

1. Insulation Resistance Test: Megger main poles of breaker pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts with breaker closed and latched to check for good, low resistance contact.
3. Test overcurrent trip device and calibrate. Where primary injection testing is specified, test each pole of the breaker individually. Data shall be compared with manufacturer's published data.
   a. All trip units shall be tested by primary injection.
   b. Static overcurrent trip devices shall be tested per manufacturer's instructions.

c. Test for minimum pick-up current.
d. Apply 300% of pick-up current and measure time necessary to trip breaker (long time delay).
e. Where short time delay characteristics are provided, test short time pick-up and delay.
f. Test instantaneous trip by passing current sufficiently high to trip breaker instantaneously.
g. Where ground fault protection is provided, test ground fault pick-up and delay.
h. Check reset characteristics of trip unit.

4. Electrically test any auxiliary devices such as shunt trips, undervoltage trips, alarm switches, and auxiliary switches.

3.05 MOTOR CONTROL CENTERS AND MOTOR CONTROLLERS

A. Visual and Mechanical Inspection

1. Verify that the contractor has cleaned structure interiors and starter cells of accumulated dust, dirt, oil films, and other foreign material.
2. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
3. Check mechanical operation of starters for freedom from binding.
4. Check motor circuit protector setting and overload relay heater size against contractor furnished list of motor nameplate full load current values.

B. Electrical Tests

1. Verify operation of each starter.
2. Test each overload relay by current injection through relay heaters. Record heater catalog numbers for each starter and submit list for maintenance. List shall contain circuit number, description of equipment and motor full load amps.
3. Contact Resistance Test. Ductor across main pole contacts of each breaker or switch with device closed and latched to check for good, low resistance contact.
4. Test overcurrent trip device of each circuit breaker trip device by current injection.

3.06 AUTOMATIC TRANSFER SWITCHES

A. Visual and Mechanical Inspection

1. Verify that contractor has cleaned enclosure interiors and all components of accumulated of dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defect or failure.
3. Perform inspection checks on individual components as recommended by the manufacturer.
4. Inspect connections for looseness. The electrical contractor shall torque wrench tighten or remake any questionable connections.

5. Inspect for missing or loose hardware or accessories.
6. Check for proper mechanical operation and lubricate, as necessary.
7. Check transfer mechanism for alignment and friction-free operation. Lubricate, as necessary.
8. Check all connecting wiring for condition.

B. Electrical Tests

1. Use test switch, when available, to check the electrical operation of the transfer switch.
2. When a test switch is not available, a failure of the normal source power will be simulated by disconnecting a voltage sensing lead.
3. Test and adjust all sensing relays, and other devices specifically associated with the transfer switch.
4. Contact Resistance Test: Ductor across main pole contacts of power switching circuit breakers, switches or contactor contacts with device closed and latched to check for good, low resistance contact.

3.07 EMERGENCY POWER SUPPLY-ENGINE DRIVEN

A. Visual and Mechanical Inspection

1. Verify that contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check output circuit breaker(s) bus connection.
4. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect for missing or loose hardware or accessories.
6. Inspect grounding system connections.
7. Operate key and door interlock devices to assure proper operation.
8. Inspect all associated systems and circuits for proper operation, including but not limited to the fuel supply system, jacket heater, battery charger, engine mounted control panel, remote monitoring and control panel, emergency cut-off, battery lighting system, exhaust system, radiator system, and ventilator system.
9. Inspect anchoring and vibration isolation systems.

B. Electrical Tests.

1. Insulation resistance test: Megger main poles of output circuit breaker(s) pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts of output circuit breaker(s) with breaker closed and latched to check for good, low resistance contact.
3. Follow completely the load testing procedures of the latest issue of NFPA-110 for EPS systems, including prior notification of the local inspection authority

having jurisdiction. Include all measured data and conditions in the final report. All non-compliance items shall be corrected by the contractor and retested until full compliance with NFPA-110 is achieved.

3.08 LIFE SAFETY SYSTEM

A. Visual and Mechanical Inspection

1. Inspect each device for physical damage.
2. Check for proper labeling of conductors.
3. Inspect all test switches for proper operation.
4. Inspect all system lamps and LED's for proper operation. Replace all non-operational equipment.
5. Check all cabinet doors latches and hinges for proper operation. Adjust, lubricate, and/or repair as required.

B. Electrical Tests

1. Verify the absence of unwanted voltages between circuit conductors and ground that would constitute a hazard or prevent proper system operation.
2. Megger test all conductors (other than those intentionally grounded) for isolation from ground.
3. Test all conductors (other than those intentionally connected together) for conductor-to-conductor isolation using as insulation testing device.
4. With each circuit pair short-circuited at the far end of the circuit, circuit resistance should be measured with an ohmmeter and recorded for each circuit. Indicate ohm values on the as-built drawings.
5. The control unit shall be tested to verify it is in the normal supervisory condition as detailed in the manufacturer's manual.
6. Each initiating and indicating circuit shall be tested to confirm that the integrity of installed conductors is being properly monitored by a suitable response at the control unit. One connection each shall be opened at no less than 10% of all initiating devices and indicating appliances.
7. Each initiating device and indicating appliance of the system shall be tested for alarm operation and proper response at the control unit. All intended functions shall be tested in accordance with the manufacturer's manual including all supplementary functions. Main and standby power supplies shall be tested.
8. Check the integrity of the software program with the system in complete operation. Verify that each message reported is correct with respect to the signal received. All possible operating conditions and system troubles shall be tested. Rewrite software as required.

3.09 LIGHTING CONTROL SYSTEM

A. Visual and Mechanical Inspection

1. Inspect each device for physical damage.
2. Check for proper labeling of conductors

3. Inspect all system lamps and LED's for proper operation. Replace all non-operational equipment.
4. Check all cabinet doors, latches, and hinges for proper operation. Adjust, lubricate, and/or repair as required.

B. Electrical Tests

1. Verify the absence of unwanted voltages between circuit conductors and ground that would constitute a hazard or prevent proper system operation.
2. Meggar test all conductors (other than those intentionally grounded) for isolation from ground.
3. Test all conductors (other than those intentionally connected together) for conductor-to-conductor isolation using as insulation testing device.
4. The control unit shall be tested to verify it is in the proper operating condition as detailed in the manufacturer's manual.
5. Each control circuit shall be tested to confirm proper operation of the circuit. Monitor the system with all building equipment energized, such as variable speed controllers, to verify the absence of control inhibiting electrical noise.

3.10 GROUNDING SYSTEM

A. Visual and Mechanical Inspection

1. Inspect wiring system outlet and junction boxes for proper grounding. Green grounding conductor shall be connected to outlet and junction boxes. Inspect a minimum of 5% of project boxes.
2. Verify connections of grounds for the secondary of separately derived grounding systems, i.e. at dry type transformers. Note type of connection, i.e. mechanical or exothermic.
3. Verify proper connection to all components of building service entrance grounding system. Note all system components which are interconnected and type of connection either mechanical or exothermic. Note depth of driven ground rods.

B. Electrical Tests (Small Systems)

1. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Instrumentation utilized shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.

C. Electrical Tests (Large Systems)

1. When sufficient spacing of electrodes described above is impractical, perform ground-impedance measurements utilizing either the intersecting curves method or the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81.)

D. Equipment Grounds

1. Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode or system.

E. Test Values

1. The main ground electrode system impedance-to-ground should be no greater than five (5) ohms for commercial or industrial systems and one (1) ohm of less for generating stations, transmission stations, and large industrial systems. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

3.11 CABLES - LOW-VOLTAGE - 600V MAXIMUM

A. Visual and Mechanical Inspection

1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
2. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
3. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

B. Electrical Tests

1. Perform insulation-resistance test on each feeder on the riser diagram with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
2. Perform continuity test to insure proper cable connection.

C. Test Values

1. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.

3.12 GROUND-FAULT SYSTEMS (NEC 230-95)

A. Visual and Mechanical Inspection

1. Inspect for physical damage and compliance with drawings and specifications.
2. Inspect neutral main bonding connection to assure:
   a. Zero-sequence sensing system is grounded.
   b. Ground-strap sensing systems are grounded through sensing device.
   c. Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
   d. Grounded conductor (neutral) is solidly grounded.
3. Inspect control power transformer to ensure adequate capacity for system.
4. Manually operate monitor panels (if present) for:
   a. Trip test
   b. No trip test
   c. Nonautomatic reset
5. Record proper operation and test sequence.

6. Set pickup and time-delay settings in accordance with the settings provided by the owner/user's electrical engineer.

B. Electrical Tests

1. Measure system neutral insulation to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
2. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
3. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
4. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
5. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
6. On multiple source, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.

C. Test Parameters

1. System neutral insulation shall be a minimum of one hundred (100) ohms, preferably one (1) megohm or greater.
2. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.
3. Relay pickup value shall be within +/- 10% of setting and in no case greater than 1200A.

3.13 SURGE ARRESTORS

A. Low-Voltage Surge Protection Devices

1. Visual and Mechanical Inspection
   a. Inspect for physical damage and compare nameplate data with drawings and specifications.
   b. Inspect for proper mounting and adequate clearances.
   c. Check tightness of connections by using calibrated torque wrench. Refer to manufacturer's instructions for proper torque levels.
   d. Check ground lead on each device for individual attachment to ground bus or ground electrode.

END OF SECTION

DIVISION 28 – ELECTRICAL

283111.01 - FIRE ALARM SYSTEM – LOW RISE MULTIPLEXED

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The work required under this section of the specifications consists of the furnishing, installation and connection of the Fire Alarm System - Low Rise Multiplexed.

B. Definition: The Fire Alarm System consists of a multi-zone control panel with alarm initiating devices as indicated on the plans.

1.3 QUALITY ASSURANCE

A. Industry Referenced Standards: The following specifications and standards are incorporated into and become a part of the specification by reference.
   1. Underwriter's Laboratories, Inc. (UL) Publications:
      a. No. 38: Manually actuated signaling box for use with Fire Protective Signaling Systems.
   2. National Electrical Manufacturer's Association (NEMA) Publications:
      a. No. SB3: Interconnection Circuitry of Non-Coded Remote-Station Protective Signaling Systems.
   3. National Fire Protection Association (NFPA):
      a. No. 70: National Electrical Code (NEC)
      b. No. 72A: Local Protective Signaling Systems

B. Acceptable Manufacturers: Products of the following manufacturers which comply with these specifications are acceptable.
   1. Edwards Division; General Signal Corp.
   2. Honeywell Inc.
   3. Johnson Controls, Inc.
   4. Cerberus Pyrotronics
   5. Simplex Time Recorder Co.

C. Coordination:

1. Review shop drawings submitted under this and other sections, as well as other divisions, to insure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications, and electrical equipment to insure access and so that clearance minimums are provided.

D. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with fire alarm systems work similar to that required for this project.
   1. Firm with manufacturer's factory trained personnel.
   2. Firm with factory authorized service organization and spare parts stock.

1.4 SUBMITTALS

A. Refer to BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of fire alarm system equipment. Include standard or typical riser and wiring diagrams, and operation and maintenance instructions for inclusion in maintenance manuals.

C. Wiring Diagrams: Submit dimensioned floor plan drawings (minimum 1/16 inch scale) for each floor plan indicating all device locations with corresponding zone next to device. Zoning shall include initiation and audio zone where applicable. Plans shall include all conduit and wiring requirements indicating system interconnection, number and size of conductors and appropriate conduit size, and ancillary devices such as end-of-line resistors. Include wiring and riser diagrams.

D. Isometric Detail: Provide isometric detail for [Fire Alarm Control Panel] [Fire Alarm Command Station] indicating all component features and space requirements.

E. Maintenance Data: Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

F. Manufacturer Certification: Submit a letter from the manufacturer's representative stating the proposed system being submitted for review complies with the specification and takes no exception.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Handle fire alarm equipment carefully to prevent damage, breaking, and scoring. Do not install damaged equipment or components; replace with new.

B. Store fire alarm equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.1 FIRE ALARM AND DETECTION SYSTEMS:

A. General: Provide complete fire alarm system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated.
   1. Combination, Non-Coded: Either manual activation of fire alarm station or activation of automatic initiating device will energize fire alarm system signaling devices and sound non-coded alarm.

B. Design system for alarm sounding continuously throughout facility.

C. System Wiring and Supervision:
   1. Provide Class 1 initiating and alarm circuits with electrical supervision for shorts and open conditions.
   2. Install diodes or resistors in fire alarm control cabinet.
   3. Power Supplies: Provide system for operation on 120 VAC power supply. Arrange control system for operation of primary power supply and trouble power supply to operate from opposite legs of three wire system.
   4. Provide battery back-up as secondary power supply. Design battery back-up to take over supply to system within 30 seconds of loss of primary system to 85% voltage. Provide battery system capable of operation of system for 24-hours under normal conditions and then for five minutes under alarm conditions.

D. Optional System Features: Provide the following features in addition to the basic system features specified elsewhere in this specification
   1. Auxiliary contacts, normally open. Provide one contact for annunciation to SCADA system.

E. System Materials: Provide basic wiring materials which comply with Division 16 Basic Electrical Materials and Methods sections, RACEWAYS and BOXES, types to be selected by Installer.
   1. Provide conductors which are listed and approved for fire alarm usage. All wiring shall be installed in conduit. Minimum size conduit shall be ¾".

2.2 SYSTEM OPERATION

A. Actuation of any alarm initiation device shall automatically initiate the following:
   1. Illuminate the system priority one alarm LED, cause an audible alarm signal to sound, display the alarm condition language message for the point in alarm at the Central Control Station.
   2. Cause all alarms to sound, all visual alarms (including exit light) to flash.
   3. Provide a signal for connection to the SCADA panel.

B. The fire alerting tone shall be a low to high "slow whoop" from 200 Hz to 830 Hz nominal lasting 2.5 seconds.

C. It shall be possible to silence the alarm signals by operating the acknowledge switch causing the zone alarm LED to cease flashing and remain illuminated. However, the activation of another zone shall repeat the entire alarm process thus causing the signals to resound.

2.3 SYSTEM FEATURES

A. The system shall include the following features as a minimum:
   1. All alarm initiating circuit wiring, signal circuit wiring, and alarm circuit wiring supervised.
   2. Automatic transfer to standby batteries upon power failure.
   3. Solid state, microprocessor based circuitry.
   4. Full supervision of all communication, monitor and signal wiring.
   5. User programmable with keyboard.
   6. Modular design to allow future expansion with a minimum of hardware additions.
   7. System automatically switches to battery operation upon loss of 60 Hz power.
   8. Operation shall not require personnel with special computer operation skills.
   9. All messages generated by the software shall be "user friendly" in plain English, not computer language. Messages shall describe condition and, based on input from the Owner, provide plain language instructions for building personnel.

2.4 CENTRAL CONTROL STATION EQUIPMENT

A. The Central Control shall be composed of a Central Processing Unit (CPU).

B. Central Processing Unit (CPU)
   1. The CPU shall include alphanumeric display, full alphanumeric key pad. The alphanumeric display shall be fully operational while the system is operating on the standby batteries.
   2. The CPU shall be housed in a wall mounted cabinet with sufficient capacity to allow maximum system expansion and to house the alphanumeric display.

3. CPU electronics shall be microprocessor based. Basic fire alarm software shall be retained in programmable read only memory, PROM, to insure trouble free system operation and simplified start-up. The CPU shall have minimum capacity of 1,000 point, exclusive of trouble points dedicated to system supervision.
4. The CPU shall be equipped with software routines to provide the Control-By-Event feature, where the receipt of an alarm point may be programmed to operate any or all of the control points within the system. Control-By-Event (CBE) actions shall generally be retained in a non-volatile Programmable Read-Only-Memory (PROM) for reliability.

2.5 MANUAL FIRE ALARM STATIONS

A. Provide manufacturer's standard construction, red enclosure, manual fire alarm stations with the following features:
   1. High Impact Lexan.
   2. Surface mounted.
   3. Non-coded.
   4. Non-breakglass operation.
   5. General alarm.
   6. Single action.
   7. Institutional cover.

2.6 HORNS

A. Provide manufacturer's standard construction fire alarm horn with following features:
   1. Non-coded.
   2. Surface mounted (with grille).
   3. Single projection.
   4. Alarm light with white lens lettered red "FIRE".

2.7 ALARM LIGHTS

A. Provide manufacturer's standard construction alarm lights with the following features:
   1. White lens, plain or lettered red "FIRE".
   2. 24-volt DC Xenon flasher.

2.8 TEST CHART INSTRUCTIONS

A. Provide fire alarm system test instructions chart mounted in lexan enclosed frame assembly on control cabinet hinged door.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which fire alarm systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF BASIC IDENTIFICATION:

A. Install electrical identification in accordance with Division-26 Basic Electrical Materials and Methods section "Electrical Identification."

3.3 INSTALLATION OF BASIC WIRING SYSTEM MATERIALS:

A. Install wiring, raceways, and electrical boxes and fittings in accordance with Division-26 Basic Electrical Materials and Methods sections, "Raceways", "Wires and Cables", and "Boxes" for wiring of non-power limited circuits. Conduit, boxes, etc shall be painted red.

B. Install wires and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals. Make soldered splices in electronic circuits in control cabinets.

3.4 INSTALLATION OF FIRE ALARM SYSTEMS:

A. Install fire alarm system as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation."

B. Wiring: Wiring of fire alarm system is work of this section, but is not specifically detailed on drawings.
   1. Complete wiring in accordance with manufacturer's requirements. Color code wiring and install per manufacturer's point-to-point wiring diagram. Determine exact number of wires for each fire area zone from number and types of devices installed. Connect each device with sufficient wiring to complete its intended operation.
   2. Where there are a number of power requiring devices such as smoke detectors, fan relays, door holders and smoke damper operators installed in a circuit, group in numbers so power required does not exceed 80% of manufacturer's power supply rating. Provide extra wiring, or extra power supplies required to fulfill that requirement. In addition, provide extra or larger size wiring to alleviate voltage drops which makes device operate beyond voltage limits for which it was

designed. Determine above with manufacturer's representative while equipment is being installed.

3.5 FIELD QUALITY CONTROL:

A. Connection and Supervision: Make connections to panel under manufacturer's supervision. Run wiring to main terminal cabinet located adjacent to main fire alarm panel. Complete connections from this cabinet to panel utilizing Manufacturer's technicians.

B. System Test and Approval: Submit shop drawings for function and operation only, pre-approved by authority having local jurisdiction.
   1. Prior to final acceptance of system, manufacturer of system shall, in presence of Contractor, Owner's Representative and Architect's representative, test each sensing or detection and alarm device.
   2. Submit copy of test results in duplicate after signed by Owner's Representative to Architect, Owner, Owner's Insurance Company and local Fire Protection Authority. Mount copy of inspection record in lexan enclosed frame assembly on control panel.
   3. Refer to ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification for additional requirements.

C. Upon project completion, the manufacturer's representative shall present for the Owner's consideration a proposal to provide semi-annual inspection and tests of the system.

END OF SECTION

INDEX TO

SECTION 31 00 00

EARTHWORK

SECTION 31 00 00

EARTHWORK

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Grading.

B. Excavation.

C. Backfilling.

D. Compaction.

E. Remove and Replace Topsoil.

F. Dressing of Shoulders and Banks.

G. Water Control.

H. Testing.

1.02 RELATED SECTIONS

A. Section 01 45 00 – Quality Control.

B. Section 01 45 23 – Testing and Inspecting Services.

C. Section 31 10 00 – Site Clearing.

1.03 REFERENCES (LATEST REVISION)

A. ASTM D 448 – Sizes of Aggregate for Road and Bridge Construction.

B. ASTM D 1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort.

C. ASTM D 2487 – Classification of Soils for Engineering Purposes (Unified Soil Classification System).

D. ASTM D 6938 – In–Place Density and Water Content of Soil and Soil–Aggregate by Nuclear Methods (Shallow Depth).

E. ASTM D 3740 – Minimum Requirements for Agencies Engaged in Testing and Inspection of Soil and Rock as Used in Engineering Design and Construction.

F. ASTM E 329 – Agencies Engaged in Construction Inspection and Testing.

1.04 SUBMITTALS

A. Section 01 00 00 – General Requirements: Procedures for submittals.

B. Materials Source: Submit gradation analysis, proctor results, and soil classification for all borrow material.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with Federal, State of South Carolina, County of Charleston, and City of Isle of Palms standards.

1.06 TESTING

A. Laboratory tests for moisture density relationship for fill materials shall be in accordance with ASTM D 1557, (Modified Proctor).

B. In place density tests in accordance with ASTM D 6938.

C. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

D. The testing laboratory and Project Engineer or Project Representative shall be given a minimum of 48 hours notice prior to taking any of the tests.

E. Testing shall be Contractor's responsibility and performed at Contractor's expense by a commercial testing laboratory operating in accordance with subparagraph C above.

F. Acceptable test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Control fill shall consist of sand or sand–clay soils capable of being readily shaped and compacted to the required densities, and shall be reasonably free of roots, trash, rocks larger than two inches, and other deleterious material.

B. All soils used for structural fills shall have a PI (plastic index) of less than ten, and a LL (liquid limit) of less than 30. Fill soils shall be dried or wetted to appropriate moisture contents prior to compaction. Additionally, fill soils used for the top two feet of fill beneath roads and parking lots shall have no more than twelve percent passing the # 200 sieve.

C. Controlled fill material should ne cohesionless soil containing no more than twelve percent fines (material passing the No. 200 sieve) by weight, having a maximum dry density of at least 100 pcf as determined by a laboratory modified Proctor compaction test (ASTM D 1557). The soil should be relatively free of organics, deleterious matter, and elongated or flat particles susceptible to degradation. All fill should be placed in uniform lifts of ten inches or less (loose measure) and

compacted to at least 95% of the modified Proctor maximum dry density. (ASTM D-1557).

Fill placement should be observed by a qualified Engineering Technician working under the direction of the Geotechnical Engineer. In addition to this visual evaluation, the Technician should perform a sufficient number of in-place field density tests to confirm the contractor's equipment and methods are capable of achieving the required degree of compaction.

D. Contractor shall furnish all fill material.

E. Contractor shall be responsible for and bear all expenses in developing borrow sources including securing necessary permits, drying the material, haul roads, clearing, grubbing, excavating the pits, placing, compaction, and restoration of pits and haul roads to a condition satisfactory to property owners, and in compliance with applicable federal, state, and local laws and regulations.

2.02 SOURCE QUALITY CONTROL

A. If tests indicate materials do not meet specified requirements, change material and retest.

B. Provide materials of each type from same source throughout the Work.

PART 3 – EXECUTION

3.01 TOPSOIL

A. Contractor shall strip topsoil and stockpile on site at a location determined by the Owner at the Contractor's expense.

B. Topsoil shall be placed to a depth of four inches over all disturbed or proposed landscaped areas.

C. Topsoil shall be provided at Contractor's expense if it is not available from site.

D. Any remaining topsoil will be hauled off site at the Contractors expense.

E. Do not excavate wet topsoil.

3.02 EXCAVATION

A. Suitable excavation material shall be transported to and placed in fill areas within limits of the work.

B. Unsuitable material encountered in areas to be paved and under building pads, shall be excavated two feet below final grade and replaced with suitable material from site or borrow excavations. Contractor shall notify Engineer if more than two feet of excavation is needed to replace unsuitable material.

C. Unsuitable and surplus excavation material not required for fill shall be disposed of off site.

D. Proper drainage, including sediment and erosion control, shall be maintained at all times. Methods shall be in accordance with the National Pollutant Discharge Elimination System standards and other local, state, and federal regulations.

E. Unsuitable materials as stated herein are defined as highly plastic clay soils, of the CH and MH designation, border line soils of the SC–CH description, and organic soils of the OL and OH description based on the Unified Soils Classification System. Further, any soils for the top two feet of pavement subbase shall have no more than 15 percent passing the # 200 sieve.

3.03 GROUND SURFACE PREPARATION FOR FILL

A. All vegetation, roots, brush, heavy sods, heavy growth of grass, decayed vegetable matter, rubbish, and other unsuitable material within the areas to be filled shall be stripped and removed prior to beginning the fill operation.

B. Sloped ground surfaces steeper than one vertical to four horizontal, on which fill is to be placed shall be plowed, stepped, or benched, or broken up as directed, in such a manner where fill material will bond with the existing surface.

C. Surfaces on which fill is to be placed and compacted shall be wetted or dried as may be required to obtain the specified compaction.

3.04 FILL

A. Shall be placed in successive horizontal layers eight inches to ten inches in loose depth for the full width of the cross–section and compacted as required.

3.05 FINISHED GRADING

A. All areas covered by the project including excavated and filled sections and adjacent transition areas shall be smooth graded and free from irregular surface changes.

B. Degree of finish shall be that ordinarily obtainable from either blade–grader or scraper operations, supplemented with hand raking and finishing, except as otherwise specified.

C. Unpaved areas to within 0.1 feet of elevations shown on the drawings provided such deviation does not create low spots that do not drain.

D. Paved Areas – Subgrade to within 0.05 feet of the drawing elevations less the compacted thickness of the base and paving.

E. Building Pads – Subgrade to within 0.05 feet of the drawing elevations [less the thickness of the concrete slab].

F. Ditches and lagoon banks shall be finished graded, dressed, and seeded within fourteen calendar days of work to reduce erosion and permit adequate drainage.

3.06 DISPOSAL OF WASTE MATERIAL

A. All vegetation, roots, brush, sod, broken pavements, curb and gutter, rubbish, and other unsuitable or surplus material stripped or removed from limits of construction shall be disposed of by the Contractor.

3.07 PROTECTION

A. Graded areas shall be protected from traffic, erosion, settlement, or any washing away occurring from any cause prior to acceptance.

B. Contractor shall be responsible for protection of below grade utilities shown on the drawings or indicated by the Owner at all times during earthwork operations.

C. Repair or re–establishment of graded areas prior to final acceptance shall be at the Contractors expense.

D. Site drainage shall be provided and maintained by Contractor during construction until final acceptance of the project. Drainage may be by supplemental ditching, or pumping if necessary, prior to completion of permanent site drainage.

3.08 DRAINAGE

A. Contractor shall be responsible for providing surface drainage away from all construction areas. This shall include maintenance of any existing ditches or those constructed in the immediate vicinity of the work. Contractor shall provide proper and effective measures to prevent siltation of wetlands, streams, and ditches on both the Owner's property, and those properties downstream.

3.09 FIELD QUALITY CONTROL

A. Compaction testing shall be performed in accordance with ASTM D 6938. Where tests indicate the backfill does not meet specified requirements, the backfill shall be reworked or removed and replaced, and then retested at the Contractor's expense.

B. Unpaved areas – at least 90 percent of maximum laboratory density within two percent optimum moisture content unless otherwise approved by the Engineer.

C. Paved Areas and Under Structures – top six inches layer of subbase to at least 98 percent of maximum laboratory density within two percent optimum moisture content. Layers below top 6 inches shall be compacted to 95 percent of maximum laboratory density within two percent optimum moisture content.

D. Rolling and compaction equipment and methods shall be subject to acceptance by the Engineer. Acceptance in no way relieves Contractor of the responsibility to perform in correct and timely means.

E. Number of Tests – Under paved areas, no less than one density test per horizontal layer per 5,000 square feet of subbase shall be made. In unpaved areas, no less than one density test per horizontal layer per 10,000 square feet of fill area shall

be made. [On building pads, no less than one density test per horizontal layer per 1,500 square feet of fill area shall be made.]

3.10 PROOF ROLLING

A. Shall be required on the subbase of all concrete and paved areas and on the base of all paved areas where designated by the Engineer. Proof rolling shall take place after all underground utilities are installed and backfilled. The operation shall consist of rolling the subbase or base with a fully loaded ten–wheeled dump truck. A full load shall consist of ten to twelve cubic yards of soil or rock. The dump truck shall be capable of traveling at a speed of two to five miles per hour and be in sound mechanical shape with no exhaust leaks or smoking from burning oil. The Engineer shall determine number of passes and areas rolled.

END OF SECTION

INDEX TO

SECTION 31 10 00

SITE CLEARING

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Removal of surface debris.

B. Removal of paving, curbs, and concrete, etc.

C. Removal of trees, shrubs, and other plant life.

D. Topsoil excavation.

1.02 RELATED SECTIONS

0Section 01 56 39 – Temporary Tree and Plant Protection.

Section 02 41 13 – Selective Site Demolition.

Section 31 00 00 - Earthwork.

1.03 REGULATORY REQUIREMENTS

A. Conform to applicable codes for environmental requirements and County and local ordinances.

B. Coordinate clearing Work with utility companies.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide tree protection materials as detailed on the construction drawings. Provide protection of existing structures during site clearing operations.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that existing plant life designated to remain is clearly identified and protected.

B. Contractor shall coordinate with Owner to identify a salvage area for placing removed materials.

3.02 PROTECTION

A. Protect all trees on site that are not identified in the Construction Drawings for removal. Refer to Section 01 56 39 Temporary Tree and Plant Protection for additional requirements regarding protection of trees.

B. Protect bench marks, survey control points, and existing structures from damage or displacement.

C. Protect all existing utilities unless noted otherwise.

D. Clearing operations shall be conducted so as to prevent damage from falling trees to trees left standing, to existing structures and installations, and to those under construction, and so as to provide for the safety of employees and others.

3.03 CLEARING

A. Clear areas required for access to site and execution of work. Clearing shall consist of felling and cutting trees into sections, and satisfactory disposal of trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within area to be cleared. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be removed completely from the site, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within cleared areas shall be trimmed of dead branches 1–1/2 inch or more in diameter. Limbs and branches to be trimmed shall be neatly cut close to the trunk of the tree or main branches. Cuts more than 1–1/2 inches in diameter shall be painted with accepted tree wound paint. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations, by the erection of timber barriers or by such other means as circumstances require. Such barriers must be placed and be checked by the Owner before construction observations can proceed (See paragraph 3.2). Clearing shall also include removal and disposal of structures obtruding, encroaching upon, or otherwise obstructing the work.

3.04 GRUBBING

A. Grubbing shall consist of the removal and disposal of stumps, roots larger than one inch in diameter, and matted roots from the designated grubbing areas. This material, together with logs and other organic or metallic debris not suitable for building of pavement subgrade or building pads, shall be excavated and removed to a depth of not less than 18-inches below the original surface level of the ground in embankment areas and not less than two feet below the finished

earth surface in excavated areas. Depressions made by grubbing shall be filled with well-compacted controlled fill, as defined in Section 31 23 13 Subgrade Preparation.

3.05 REMOVAL

A. Additional Removals: Where indicated or directed, trees and stumps shall be removed from areas outside those areas designated for clearing and grubbing. The work shall include the felling of such trees and the removal of their stumps and roots. Trees shall be disposed of as hereinafter specified. Remove debris, rock, and other extracted plant life from site. Partially remove paving, curbs, and concrete, as indicated. Neatly saw cut edges at right angle to surface.

B. Following all clearing, grubbing and removal, any resulting voids created shall be backfilled with well-compacted controlled fill, as defined in Section 31 23 13 Subgrade Preparation. The existing fill soils may remain in place if they are deemed sufficiently stable by the Geotechnical Engineer at the time of Construction.

3.06 DISPOSAL

A. Disposal of trees, branches, snags, brush, stumps, etc., resulting from the clearing and grubbing shall be removed from the site and is the responsibility of the Contractor. All costs in connection with disposing of the material shall be borne by the Contractor. All liability associated with the disposal of the cleared and grubbed material shall be the responsibility of the Contractor. The disposal of all materials cleared and grubbed shall be in accordance with the state and local regulations.

3.07 GEOTECHNICAL RECOMMENDATIONS

A. All site clearing activity shall be in conformance with the Geotechnical Recommendations provided by Terracon for this project.

3.08 COUNTY REQUIREMENTS

A. Adhere to all County requirements.

END OF SECTION

INDEX TO

SECTION 31 23 13

SUBGRADE PREPARATION

SECTION 31 23 13

SUBGRADE PREPARATION

PART 1 – GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM): D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-Ibflft3 (2,700 *kN-m1m3*)).

B. South Carolina Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition (SCDOT Standard Specifications).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

D. Subgrade: Layer of existing soil after completion of clearing, grubbing, and scalping of topsoil, prior to placement of fill, roadway structure, or base for floor slab.

E. Proof-Rolling: Testing of subgrade by compaction methods to identify areas that will not support the future loading without intolerable settlement.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 31 10 00 Site Clearing and Section 31 23 16 Excavation, prior to subgrade preparation.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under and Adjacent to Structures, Slabs, Pavements, Footings and Sidewalks: The area under and ten feet beyond the footprint of proposed facilities shall be proof-rolled after removal of topsoil and before placement of fill. Proof-roll shall be with a minimum of ten overlapping passes using a fifteen ton or heavier vibratory roller. The upper twelve inches of the bottom shall be compacted to at least 95 percent of the modified Proctor maximum dry density, as determined by ASTM D1557. Any soft areas that cannot be compacted shall be over-excavated and replaced with compacted sand, silty sand, or other material, as determined by the Geotechnical Engineer. Subgrade compaction under pavement areas shall be in accordance with the SCDOT standard specifications.

B. All compacted subgrade in footprint of new structures shall be inspected by Geotechnical Engineer and accepted prior to placing fill or other material.

C. Under Earthfill: Compact upper twelve inches to a minimum of 95 percent of the modified Proctor maximum dry density, as determined in accordance with ASTM D1557.

3.03 MOISTURE CONDITIONING

A. Dry Sub grade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

A. Testing methods and frequencies shall be determined by the Geotechnical Engineer. At a minimum, provide one test per every 5,000 square feet on every lift of sub grade or two tests per lift, whichever is greater.

3.05 CORRECTION

A. Soft or Loose Sub grade:

1. Adjust moisture content and re-compact; or

2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Over excavate as specified in Section 31 23 16 Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23 Fill and Backfill.

END OF SECTION

INDEX TO

SECTION 31 23 16

EXCAVATION

SECTION 31 23 16

EXCAVATION

PART 1 – GENERAL

1.01 DEFINITIONS

A. Common Excavation: Removal of material not classified as rock excavation.

1.02 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized over-excavation.

B. Excavation Support: When performing trench excavation in excess of five feet in depth, comply with Occupational Safety and Health Administration's (OSHA) trench safety standards, 29 CFR, s. 1926.650, Subpart P, and all subsequent revisions or updates adopted by the Department of Labor and Employment Security. Ensure that trench boxes are wide enough to accommodate compaction and density testing. The excavation support system shall be designed by a professional Engineer registered in the State of South Carolina.

1.03 WEATHER LIMITATIONS

A. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction. If this occurs, Geotechnical Engineer shall approve material prior to use.

1.04 SEQUENCING AND SCHEDULING

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

B. Dewatering: Conform to applicable requirements of Section 31 23 19.01 Dewatering, prior to initiating excavation.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. An unbraced temporary excavation with side slope inclined at one and a half Hertz to 1 Volt or flatter is expected to remain stable if not subject to surcharge load or vibration. Excavation deeper than five feet shall comply with OSHA trench safety standards, 29 CFR, s. 1926.650,

C. Surface water runoff should be prevented from entering trenches by temporary berms, swales, or other diversion methods.

D. Do not over–excavate without written authorization of Engineer.

E. Maintain subsurface with a minimum of twelve inches below excavations.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 EXCAVATION AROUND PILES

A. Excavation of areas where piles are to be installed shall be performed with acceptable equipment to six to twelve inches above the base of the footing or pile cap. This will occur prior to installation of piles.

B. Following installation of piles, excavation of remaining area around and between piles shall be performed by hand and shall not damage or dislocate piles.

3.04 TRENCH WIDTH

A. Minimum Width of Trenches: Excavate trenches for pipes to the elevation of the bottom of the pipe or sub-base as specified on the Drawings. The width should be sufficient to provide adequate working room for pipe installation and connections.

3.05 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform to lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed three-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a dix-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.06 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

C. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

D. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.07 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

B. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

INDEX TO

SECTION 31 23 19.01

DEWATERING

SECTION 31 23 19.01

DEWATERING

PART 1 – GENERAL

1.01 SUBMITTALS

A. Informational Submittals: Copies of any authorization and permits required to perform dewatering activities.

1. Water control plan.

2. Well permits.

3. Discharge permits.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

3.01 GENERAL

A. The Contractor shall be responsible for design, installation, and operation of a dewatering system to keep excavation free of water.

3.02 SURFACE WATER CONTROL

A. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in the dry and to lower and maintain groundwater level a minimum of two feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. Dewatering systems shall include wells or well points and other equipment and appurtenances necessary to maintain specified groundwater elevation. Systems shall be installed outside structural limits and sufficiently below lowest point of excavation.

C. Design and Operate Dewatering Systems:
1. To prevent loss of ground as water is removed.

2. To avoid inducing settlement or damage to existing facilities completed Work, or adjacent property.

3. To relieve artesian pressures and resultant uplift of excavation bottom.

D. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

3.04 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

END OF SECTION

INDEX TO

SECTION 31 23 23

FILL AND BACKFILL

SECTION 31 23 23

FILL AND BACKFILL

PART 1 – GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):

a. CI17, Standard Test Method for Materials Finer Than 75–Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.

b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

c. D75, Standard Practice for Sampling Aggregates.

d. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand–Cone Method.

e. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft.–lbf/ft^3 (2,700 kN–m/m3).

f. D2922, Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as–compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.

2. Apply corrections for oversize material to either as–compacted field dry density or maximum dry density, as determined by Geotechnical Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4–inch sieve.

C. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and sub grade preparation.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Lift: Loose (uncompacted) layer of material.

F. Geosynthetics: Geotextiles, geogrids, or geo–membranes.

G. Well–Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.

2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

H. Influence Area: Area within planes sloped downward and outward at 60–degree angle from horizontal measured from:

1. One foot outside outermost edge at base of foundations or slabs.

2. One foot outside outermost edge at surface of roadways or shoulder.

3. One-half foot outside exterior at spring line of pipes or culverts.

I. Borrow Material: Material from required excavations or from designated borrow areas on or near Site. Material to be provided by Contractor.

J. Selected Backfill Material: Materials available onsite that geotechnical Engineer determines to be suitable for specific use.

K. Imported Material: Materials obtained from sources offsite, suitable for specified use.

L. Granular Fill: Fill materials as required under structures, pavements, and other facilities.

M. Embankment Material: Fill materials required to raise existing grade in areas other than under structures, pavements, and other facilities.

N. Standard Specifications: When referenced in this section, shall mean South Carolina Department of Transportation Standard Specification for Road and Bridge Construction, latest edition.

O. Controlled Fill: Fill materials as required under structures, around pipes, in trenches, and backfill for structures. As defined herein, in accordance with the Geotechnical Report.

1.03 SUBMITTALS

A. Informational Submittals: Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure, tank, or area is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.

2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.

3. Fill material appears to be deviating from Specifications.

B. Testing and Inspection Services:

1. An independent geotechnical testing agency, qualified in accordance with ASTM E 329, shall, at a minimum, conduct soil materials and properties and compaction testing. The geotechnical testing agency shall designate, from within, a Geotechnical Engineer, registered in the state of South Carolina, to serve as the main point of contact and geotechnical advisor on the project during construction.

2. The Owner shall approve of the testing agency.

3. The testing agency will be paid for by the Contractor.

4. At a minimum, in-place field density tests shall be conducted at the following locations. Exact locations are to be determined by the Geotechnical Engineer.

    a. One test within the Building footprints.
    b. Two tests shall be conducted within the main Basin footprint.
    c. One test shall be conducted on the south end of the main Basin structure where the equipment pads are located.
    d. One test shall be conducted within the Primary Influent Screen footprint.
    e. Other locations as designated by the Geotechnical Engineer.

5. Contractor shall provide access for testing agency to perform soil testing and inspection services for quality control during earthwork operations.

6. Fill and Backfill placement shall be observed by a qualified Engineering Technician working under the direction of the designated Geotechnical Engineer.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 13 Selective Site Demolition, Section 31 10 00 Site Clearing, Section 31 23 16 Excavation, and Section 31 23 13 Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, as specified in Section 03 30 00 Cast–in–Place Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water–holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00 Cast–in–Place Concrete.

D. Backfill around buried tanks only after tank is set in position and anchored and exterior pipes and other equipment are in place and securely anchored.

E. Do not place granular base, sub–base, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 – PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests:

1. As necessary to locate acceptable sources of imported material.

2. During production of imported material, test as follows:

a. Granular Fill: One Test per 2,000 CY.

B. Samples: Collected in accordance with ASTM D75:

1. During production of imported material, provide Samples as follows:

a. Granular Fill: One sample for every 2,000 CY.

2.02 EARTH FILL

A. Excavated material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Provide imported material of equivalent quality, if required, to accomplish Work.

2.03 GRANULAR FILL

A. One–inch minus crushed gravel, sand, or crushed rock.

B. Free from dirt, clay balls, and organic material.

C. Well–graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 12 percent by weight passing No. 200 sieve.

2.04 CONTROLLED FILL

A. Cohesion-less soil containing a maximum of 12 percent by weight passing No. 200 sieve.

B. The soil shall be free of organics, deleterious material and elongated or flat particles susceptible to degradation.

C. A maximum dry density of at least 100 pcf as determined by a laboratory modified Proctor compaction test (ASTM D1557).

D. Uses classifications SP, SM, SP-SM, GP, GW, and SW.

2.05 WATER FOR MOISTURE CONDITIONING

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

2.06 BASE COURSE

A. As specified in Section 32 11 23, Aggregate Base Courses.

PART 3 – EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. All fill and backfill placement shall be observed by a qualified Engineering Technician working under the direction of the Geotechnical Engineer.

C. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation. Compact each lift to specified density prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water. Place in maximum thickness of loose fill layers of ten inches (use maximum thickness of two to four inches if hand-guided equipment (jumping jack or plate compactor) is used).

D. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

E. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

F. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation two feet above top of item to be laid.

2. Excavate trench for installation of item.

3. Install bedding, if applicable, as specified in Section 31 23 23.15 Trench Backfill.

4. Install item.

5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15 Trench Backfill, before resuming filling or backfilling specified in this section.

G. Tolerances:

1. Final Lines and Grades: Within a tolerance of one-tenth of a foot unless dimensions or grades are shown or specified otherwise.

2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

H. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

I. Use of granular and controlled fill material shall be approved by the Geotechnical Engineer. Alternate material may be designated by Geotechnical Engineer to replace soft yielding soil if deemed necessary.

3.02 BACKFILL

A. Under Site Features: Within influence area beneath sidewalks, pavements, curbs, piping, conduits, duct banks, and other site facilities, backfill with Granular Fill, unless otherwise shown. Place in lifts of 10–inch maximum thickness and compact each lift to minimum of 97 percent of the modified Proctor maximum dry density, as determined in accordance with ASTM D1557.

B. Under Structural Features: Within influence area beneath structural slabs and foundations, backfill with Controlled Fill, unless otherwise shown. Place in lifts of 10–inch maximum thickness and compact each lift to minimum of 97 percent of the modified Proctor maximum dry density, as determined in accordance with ASTM D1557.

C. Around Tanks and against Basin walls: Install Controlled Fill and place in lifts of 10–inch maximum thickness and compact each lift to minimum of 97 percent of the modified Proctor maximum dry density, as determined in accordance with ASTM D1557. Geotechnical Engineer shall provide allowable methods of compaction in these areas.

D. Other Areas: Backfill with earth fill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 10–inch maximum

thickness and compact each lift to minimum 97 percent of the modified Proctor maximum dry density, as determined in accordance with ASTM D1557.

3.03 FILL

A. Outside Influence Areas and not Beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earth fills as follows:

1. Allow for four–inch thickness of topsoil where required.

2. Maximum 10–inch thick lifts.

3. Place and compact fill across full width of embankment.

4. Compact to minimum 97 percent of the modified Proctor maximum dry density, as determined in accordance with ASTM D1557.

5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

A. Gradation:

1. Frequency shall be determined by Geotechnical Engineer. At a minimum, one sample from each 1,500 tons of finished product. If variation in gradation is occurring or if material appears to depart from Specifications, more frequent sampling may be required.

2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.

3. Remove material that does not meet Specification requirements.

B. At a minimum, both in-place field density (ASTM D1556 or D2922) and compaction (ASTM D1557 or other permitted by Geotechnical Engineer) tests shall be conducted during placement of materials in accordance with the following list (except where noted otherwise). Exact locations are to be determined by the Geotechnical Engineer.

1. Two tests within the Building footprint.
2. Six tests shall be conducted within the main Basin footprint.
3. Two tests shall be conducted on the south end of the main Basin structure where the equipment pads are located.
4. Two tests shall be conducted within the Primary Influent Screen footprint.
5. One density test for every 2,000 square feet of each lift or one test per lift, whichever is greater.
6. Other locations as designated by the Geotechnical Engineer.

C. Contractor shall provide access for testing agency to perform soil testing and inspection services for quality control during earthwork operations.

3.05 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23 Aggregate Base Courses and the Standard Specifications.

3.06 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath footings: Controlled Fill.

2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.

3. Beneath Slabs–On–Grade: Controlled Fill.

4. Trenches:

a. Unauthorized Over–excavation: Granular Fill.

b. Authorized Over–excavation: Granular Fill.

5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):

a. Flat to Moderate Steep Slopes (3: 1, Horizontal Run: Vertical Rise or Flatter): Earth fill.

b. Steep Slopes (Steeper than 3:1):

1. Correct over–excavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right–of–ways, or adversely impacts existing facilities, adjacent property, or completed Work.

2. Backfilling over–excavated areas are prohibited, unless in Engineer's opinion, backfill will remain stable, and over–excavated material is replaced as compacted earth fill.

3.07 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 2, Aggregate Base Courses and the Standard Specifications.

END OF SECTION

INDEX TO

SECTION 31 23 23.15

TRENCH BACKFILL

SECTION 31 23 23.15

TRENCH BACKFILL

PART 1 – GENERAL

1.01 REFERENCES

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

1. Fort Pierce Utility Authority Design and Construction Standards for Water and Wastewater System, latest edition.

2. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.

3. ASTM International (ASTM):

a. C33, Standard Specification for Concrete Aggregates.
b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
c. C 117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
e. C150, Standard Specification for Portland Cement.
f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
g. D1140, Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.
h. D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft.-lbf/ft^3 (2,700 kN-mlm^3)).

4. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Color Code.

1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as compacted field dry density or maximum dry density, as determined by Engineer.

H. Selected Backfill Material: Material available onsite that Geotechnical Engineer determines to be suitable for a specific use.

I. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.

2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.

PART 2 – PRODUCTS

2.01 MARKING TAPE

A. Plastic:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.

2. Thickness: Minimum 4 mils.

3. Width: 3 inches.

4. Identifying Lettering: Minimum one-inch high, permanent black lettering imprinted continuously over entire length.

5. Manufacturers and Products:

   a. Reef Industries; Terra Tape.
   b. Allen; Markline.

B. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.

2. Foil Thickness: Minimum 5.5 mils.

3. Width: 3 inches.
4. Identifying Lettering: Minimum one-inch high, permanent black lettering imprinted continuously over entire length.

5. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.

6. Manufacturers and Products:

   a. Reef Industries; Terra "D."
   b. Allen; Detectatape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, effluent water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.02 TRENCH STABILIZATION MATERIAL

A. No 57 stone (granite).

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Granular fill as specified in Section 31 23 23 Fill and Backfill.

2.04 EARTH BACKFILL

A. Earth fills as specified in Section 31 23 23 Fill and Backfill.

B. Free from roots or organic matter, refuse, boulders and material larger than 112 cubic feet, or other deleterious materials.

2.05 GRAVEL SURFACING ROCK

A. As specified in Section 32 11 23 Aggregate Base Courses.

2.06 SOURCE QUALITY CONTROL

A. Perform gradation analysis, as specified by Geotechnical Engineer, in accordance with ASTM C136 for:

1. Earth backfill, including specified class.

2. Trench stabilization material.

3. Bedding and pipe zone material.

PART 3 – EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water. Control groundwater as specified in Section 31 23 19.01 Dewatering.

2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.

3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and any backfill materials that are contaminated with foreign materials that fall into trench.

3.02 TRENCH BOTTOM

A. Firm Sub grade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of over excavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in six-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds eight inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness as follows:

1. Pipe 15 Inches and Smaller: four inches.

2. Pipe 18 Inches to 36 Inches: six inches.

3. Pipe 42 Inches and Larger: eight inches.

4. Conduit: three inches.

5. Direct-Buried Cable: three inches.

6. Duct Banks: three inches.

E. Check grade and correct irregularities in bedding material. Loosen top one inch to two inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.05 BACKFILL PIPE ZONE

A. Upper Limit of Pipe Zone shall not be Less than Following:

1. Pipe: 12 inches, unless shown otherwise.

2. Conduit: three inches, unless shown otherwise.

3. Direct-Buried Cable: three inches, unless shown otherwise.

4. Duct Bank: three inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe Ten-Inch Diameter and less: First lift less than or equal to pipe diameter.

2. Pipe Over Ten-Inch Diameter: Maximum six-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by mechanical tamping equipment, plate vibratory compaction, and or concrete vibrators to ensure that voids are completely filled before placing each succeeding lift.

E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls. Compact the pipe zone material to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

F. Do not use power-driven impact compactors to compact pipe zone material.

3.06 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, on top of last lift of pipe zone material. Coordinate with piping installation Drawings.

3.07 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.

2. Adjust moisture content as necessary to obtain specified compaction.

3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least two feet of backfill has been provided over the top of pipe.

4. Do not use power driven impact type compactors for compaction until at least four feet of backfill is placed over top of pipe.

5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.

6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

3.08 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top six inches of backfilled trench.

B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface. Grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

D. Concrete Pavement: Replace settled slabs as specified in Section 32 12 16 Asphalt Paving.

E. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16 Asphalt Paving.

F. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

INDEX TO

SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROLS

SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROLS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions apply to this section.

1.02 DESCRIPTION OF WORK

A. Extent of soil erosion control work includes all measures necessary to meet the requirements of this section and the construction Drawings.

B. Erosion and sediment control measures shall be installed prior to any construction activity.

C. Soil erosion and sediment control measures shall include all temporary and permanent means of protection and trapping soils of the construction site during land disturbing activity. Activity covered in this contract shall meet standards of NPDES General Permit for the state where work is performed.

1.03 PURPOSES

A. Contractor is to achieve the following goals:

1. Minimize soil exposure by proper timing of grading and construction.

2. Retain existing vegetation whenever feasible.

3. Vegetate and mulch denuded areas as soon as possible.

4. Divert runoff away from denuded areas.

5. Minimize length and steepness of slopes when it is practical.

6. Reduce runoff velocities with sediment barriers or by increasing roughness with stone.

7. Trap sediment on site.

8. Inspect and maintain erosion control measures.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of soil erosion control systems products of types and sizes required, whose materials have been in satisfactory use for not less than five years.

B. Codes and Standards: Comply with all applicable Local, State, and Federal Standards pertaining to soil erosion control.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instruction for soil erosion control materials and products.

1.06 MEASUREMENT AND PAYMENT

A. No unit measurements will be made for soil erosion control. Payment will be made at the lump sum price as shown on the bid proposal. The cost of soil erosion control shall include all equipment, labor and materials necessary to comply with the State of South Carolina Erosion and Sediment Control Program.

PART 2 – PRODUCTS

2.01 GRASSING MATERIALS

A. General: All grass seed shall be free from noxious weeds, grade A recent crop, recleaned and treated with appropriate fungicide at time of mixture. Deliver to site in original sealed containers with dealer's guarantee as to year grown, percentage of purity, and percentage of germination and date of the test by which percentages of purity and germination were determined. All seed sown shall have a date of test within six months of the date of sowing.

B. Type of Seed: Either Annual Rye or Common Bermuda Grass seed will be used depending on time of year in which seeding is to occur.

C. Mulch: Straw.

D. Fertilizer: Commercial balanced 4–12–12 fertilizer.

2.02 HAY BALES/SEDIMENT ROLLS

A. Standard size, densely baled straw or hay or synthetic sediment rolls, wrapped with synthetic or wire bands or mesh.

2.03 SILT FENCE

A. Silt fence shall be a woven geotextile fabric sheet. Fabric shall be a synthetic polymer composed of at least 85 percent by weight propylene, ethylene, amide, ester, or vinylidene chloride, and shall contain stabilizer or inhibitors added to the base plastic to make filaments resistant to deterioration due to ultra–violet or heat exposure. Fabric should be finished so the filaments will retain their relative position with respect to each other. Fabric shall be free of defects, rips, holes, or flaws.

Fabric shall meet the following requirements:

Woven Fabrics	
Grab Strength	90 lbs.
Burst Strength	175 PSI
UV Resistance	80%

2.04 CHEMICALS FOR DUST CONTROL

A. Calcium Chloride, Anionic Asphalt Emulsion, latex Emulsion or Resin–in–Water Emulsion may be used for dust control.

2.05 RIP–RAP

A. Shall be hard quarry or field stone of such quality the pieces will not disintegrate on exposure to water, sunlight, or weather. Stone shall range in weight from a minimum of 25 pounds to a maximum of 125 pounds. At least 50 percent of the stone shall weigh more than 60 pounds. The stone shall have a minimum dimension of 12 inches.

2.06 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. Engineer will review all products before they are ordered.

PART 3 – EXECUTION

3.01 GENERAL

A. All disturbed soil areas except those to support paving shall be graded and protected from erosion by grassing. Disturbed areas must be grassed within 14 days of work ending unless work is to begin again before 21 days. Storm water conveyance systems shall have sediment barriers installed at all entrances, intersections, change in direction and discharge points.

3.02 GRASSING

A. Preparation: After all other construction work is completed, and the surface has been finished to subgrade, topsoil shall be spread over the area to be grassed in a uniform layer not less than four inches thick. Topsoil from other sources, shall be furnished by the Contractor if necessary to cover the area to be planted to the specified depth. Plow and disc in both directions, when feasible, and then remove all large particles that cannot be broken. Carefully finish the entire area to exact line and grade and shape the surface properly around structures.

B. Fertilizer and Lime: After ground preparation is complete, the area to be seeded shall then have commercial fertilizer (800 pounds per acre: 13-13-13) and lime (1.5 tons per acre: dolomitic or calcitic lime) applied at the recommended rate.

C. All seed shall meet the requirements of these specifications and comply with applicable state law. The type of grass seed to be planted shall meet the

approval of the Owner. Seed shall be delivered in sealed bags, properly labeled. Seeds of legumes shall be inoculated just before use with the appropriate culture.

D. Sowing of seed shall promptly follow incorporation of fertilizer. Sowing shall be done uniformly by approved mechanical seeders.

E. Immediately after sowing, the seeded area shall be harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil one and one fourth inches thick. After seed is properly covered, the seeded area shall be compacted immediately by means of a cultipacker, light roller, or approved drag.

F. The Contractor shall water, fill washes, and otherwise protect and maintain the seeded areas until the contract is accepted. It shall be the responsibility of the Contractor to establish and maintain a satisfactory stand of grass, a satisfactory stand being defined as a complete cover of living grass (limited to species previously identified herein).

3.03 SEDIMENT BARRIERS

A. Hay Bales/Sediment Rolls for Sheet Flow Applications:

1. Excavate a four inch deep trench the width of a bale and length of proposed barrier. Barrier should be parallel to the slope. Place barrier five to six feet away from toe of slope, unless otherwise instructed.

2. Place bales/rolls in the trench with their ends tightly abutting. Corner abutment is not acceptable. A tight fit is important to prevent sediment from escaping through spaces between the bales.

3. Backfill the trench with previously excavated soil and compact it. Backfill soil should conform to ground level on downhill side of barrier and should be built up to four inches above ground on uphill side of bales.

4. Inspect and repair or replace damaged bales promptly. Remove bales/rolls when uphill sloped areas have been permanently stabilized.

B. Rock Ditch Check

1. Excavate a six inch deep trench the width and length of proposed barrier. Install a non–woven geotextile fabric in the trench before placing rock for the ditch check.

2. The body of the ditch check shall be constructed of 12 inch rip–rap. The upstream face may be covered with one–inch washed stone.

3. Ditch checks shall not exceed a height of two feet at centerline of the channel and have a minimum top flow length of two feet.

4. Rip–rap shall be placed over the channel banks to prevent water from flowing around ditch check. Rock must be installed by hand or mechanical placement (no dumping of rock) to achieve complete

coverage of the ditch and ensure the center of the check is lower than the edges.

5. The maximum spacing between ditch checks shall be where the toe of the upstream check is at the same elevation as the top of the downstream check.

6. Contractor shall maintain ditch checks as required by State regulations.

3.04 SILT FENCE

A. Silt fence shall be placed at approximate location shown and installed in accordance with the detail on the construction drawings. Contractor shall maintain silt fence as required by state regulations.

3.05 DUST CONTROL

A. Dust raised from vehicular traffic will be controlled by wetting down access road with water or by the use of a deliquescent chemical, such as calcium chloride, if relative humidity is over 30 percent. Chemicals shall be applied in accordance with manufacturer's recommendations.

B. Contractor shall use all means necessary to control dust on and near the work, or off–site borrow areas when dust is caused by operations during performance of work or if resulting from the condition in which any subcontractor leaves the site. Contractor shall thoroughly treat all surfaces required to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of work on site.

3.06 SEDIMENT BASIN

A. A sediment basin equal in volume to 3,600 cubic feet per disturbed acre is required. The sediment basin adjacent to the outfall for the site shall be constructed and stabilized prior to any additional land disturbed activity.

3.07 RIP–RAP

A. Rip–Rap shall be placed at the locations shown and installed in accordance with the detail on the construction drawings.

3.08 CONSTRUCTION EXIT

A. Construct exit at the location shown per detail on the construction drawings. Contractor shall maintain construction exit as required by state regulations.

3.09 INLET PROTECTION

A. Install inlet protection per detail on the construction drawings. Contractor shall maintain inlet protection as required by state regulations until all disturbed surfaces are stabilized.

END OF SECTION

INDEX TO

SECTION 31 31 16

TERMITE CONTROL

SECTION 31 31 16

TERMITE CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following for termite control:

1. Soil treatment.

1.03 SUBMITTALS

A. Product Data: Treatments and application instructions, including EPA-Registered Label.

B. Product Certificates: Signed by manufacturers of termite control products certifying that treatments furnished comply with requirements.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

D. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following as applicable:

1. Date and time of application.

2. Moisture content of soil before application.

3. Brand name and manufacturer of termiticide.

4. Quantity of undiluted termiticide used.

5. Dilutions, methods, volumes, and rates of application used.

6. Areas of application.

7. Water source for application.

E. Test Results: Furnish written test results, performed by South Carolina Department of Fertilizer and Pest Control, showing that treatment meets requirements of specifications.

F. Warranties: Special warranties specified in this Section.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: A PCO who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located and who is experienced and has completed termite control treatment similar to that indicated for this Project and whose work has a record of successful in-service performance. All termite pesticides shall be provided in strict accordance to South Carolina Pesticide Control Act [SC Law 46-13 and amendments] and Federal Regulations. The contractor shall notify Clemson University Pesticide Regulation and Controls program prior to beginning of treatment and application. Applicators shall also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control.

B. Regulatory Requirements: Formulate and apply termiticides, and label with a Federal registration number, to comply with EPA regulations and authorities having jurisdiction.

C. Standards for Application: Current edition of South Carolina Division of Regulatory and Public Service Programs Standard 27-1085.

1.05 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with EPA-Registered Label requirements and requirements of authorities having jurisdiction.

B. Soil Moisture:

1. Soils to be treated shall be tested immediately before application. Soil moisture content shall be tested to a minimum depth of 3 inches. The soil moisture shall be as recommended by the termiticide manufacturer. The termiticide will not be applied when soil moisture exceeds manufacturer's recommendations because termiticides do not adhere to the soil particles in saturated soils.

1.06 COORDINATION

A. Coordinate soil treatment application with excavating, filling, and grading and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs, before construction.

1.07 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

C. Warranty Period: Five years from date of Substantial Completion. Warranty shall be transferred to the Owner.

D. Monitoring and Continued Service: Monitoring and continued service with applicator shall be responsibility of the Owner after the first year from the date of submittal completion.

1.08 MAINTENANCE SERVICE

A. Continuing Service: Provide a proposal for continuing service, including monitoring, inspection and retreatment for occurrences of termite activity, from applicator to Owner, in the form of a standard yearly continuing service agreement, starting on the date of Substantial Completion. State services, obligations, conditions and terms for agreement period and for future renewal options.

1.9 SAFETY REQUIREMENTS

A. The Contractor shall formulate, treat, and dispose of termiticides and their containers in accordance with label directions and regulatory requirements. Use the clothing and personal protective equipment specified on the labeling for use during all phases of the application.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. Termiticide material shall be delivered to the site in the original unopened containers bearing legible labels indicating the EPA registration number and manufacturer's registered uses. All other materials to be used on site for the purpose of termite control shall be delivered in new or otherwise good condition as supplied by the manufacturer or formulator.

B. Storage

1. Materials shall be stored in designated areas and in accordance with manufacturer's labels. Termiticides and related materials shall be kept under lock and key when unattended.

C. Handling

1. Termiticides shall be handled in accordance with manufacturer's labels. Manufacturer's warnings and precautions shall be observed. Materials shall be handled preventing contamination by dirt, water, and organic material. Protect termiticides from sunlight as recommended by the manufacturer.

1.11 INSPECTION

A. Termiticides shall be inspected upon arrival at the job site for conformity to type and quality. Each label shall be inspected for conformance with specified requirements. Unacceptable materials shall be removed from the job site.

PART 2 – PRODUCTS

2.01 SOIL TREATMENT

A. Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or emulsible, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation. Use only soil treatment solutions that are not harmful to plants. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA-Registered Label.

1. Use compatible dye in termiticide solution to provide visible evidence of treatment.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BASF Corporation, Agricultural Products; Termidor.

2. Bayer Environmental Science; Premise 75.

3. Control Solutions, Inc.; Bifen I/T.

4. FMC Corporation, Agricultural Products Group; Talstar.

5. Syngenta; Probuild TC.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of the soil, interfaces with earthwork, slab and foundation work, landscaping, and other conditions

affecting performance of termite control. Proceed with application only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparing substrate. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended by termiticide manufacturer.

C. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.03 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.04 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute the treatment evenly.

1. Slabs-on-Grade: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.

2. Foundations: Adjacent soil including soil along entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers, piers, and chimney bases; and along entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.

3. Masonry: Treat voids.

4. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

D. Post warning signs in areas of application.

E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.05 VERIFICATION OF MEASUREMENT

A. Once termiticide application has been completed, tank contents shall be measured to determine the remaining volume. The total volume measurement of used contents for the application shall equal the established application rate for the project site conditions. The Contractor shall provide written verification of the measurements.

3.06 CLEAN UP, DISPOSAL, AND PROTECTION

A. Once application has been completed, the Contractor shall proceed with clean up and protection of the site without delay.

1. Clean Up

a. The site shall be cleaned of all material associated with the treatment measures, according to label instructions, and as indicated. Excess and waste material shall be removed and disposed offsite.

2. Disposal of Termiticide

a. The Contractor shall dispose of residual termiticides and containers off Owner property, and in accordance with label instructions and EPA criteria.

3. Protection of Treated Area

a. Immediately after the application, the area shall be protected from other use by erecting barricades and providing signage as required or directed.

3.07 CONDITIONS FOR SATISFACTORY TREATMENT

A. Equipment Calibrations and Measurements

1. Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

B. Testing

1. Should an analysis, performed by a third party, indicate that the samples of the applied termiticide contain less than the amount of active

ingredient on the label, and/or if soils are treated to a depth less than specified or approved, re-treatment will be required.

C. Disturbance of Treated Soils

1. Soil and fill material disturbed after treatment shall be re-treated before placement of slabs or other covering structures.

D. Termites Found Within the Warranty Period

1. If live subterranean termite infestation or termite damage is discovered during the warranty period, the Contractor shall re-treat the site.

3.08 RE-TREATMENT

A. Where re-treatment is required, the Contractor shall:

1. Re-treat the soil and/or perform other treatment as necessary for prevention or elimination of subterranean termite infestation.

2. Repair damage caused by termite infestation.

END OF SECTION

SECTION 31 62 13

PRESTRESSED CONCRETE PILES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Prestressed precast concrete piles.

1.2 RELATED SECTIONS

A. Section 310000 – Earthwork

B. Section 312313 – Subgrade Preparation

C. Section 033000 - Cast-In-Place Concrete

D. Section 316244 – Pile Load Test

1.3 REFERENCES (LATEST REVISION)

A. AASHTO M 203 – Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

B. ACI 301 – Specifications for Structural Concrete.

C. ACI 543R – Recommendations for Design, Manufacture and Installation of Concrete Piles.

D. ASTM A 706 – Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.

E. PCI JR 382 – Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling.

F. PCI MNL-116 – Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

1.4 MEASUREMENT AND PAYMENT

A. Production Piles:

1. Base proposal on the number and length of piles indicated on construction drawings.

2. Accepted piles will be paid for at the contract price per unit length for the piles procured.

3. Contract pricing shall include a lump sum cost of the project which shall include the cost of piles. A unit price per length for piles shall also be included with the contract pricing and shall be used for pile length adjustments (if needed) or changes in pile quantities.

B. Payment for piles shall constitute full compensation for all costs of furnishing, driving, jetting, spudding, and cutting off of piles, disposing of cut-offs, furnishing, placing and removing temporary bracing required to hold piles in alignment, and other work necessary to complete the project as specified herein.

1.5 PERFORMANCE REQUIREMENTS

A. Drive piles under equipment/operations building to a depth capable of supporting an axial load of 60 tons. Pile lengths stated on the drawings are assumed to achieve the needed capacity. This is to be confirmed through results of pile testing. Test piles shall be 5 feet longer.

B. Drive piles under water treatment structure basins to a depth capable of supporting an axial load of 30 tons. Pile lengths stated on the drawings are assumed to achieve the needed capacity. This is to be confirmed through results of pile testing. Test piles shall be 5 feet longer.

C. Design piles to resist the following:

1. Piles under equipment / operations building: axial load of 60 tons and lateral load of 11 tons (factored loads).

2. Piles under water treatment structure basins: axial load of 30 tons and lateral load of 5 tons (factored loads).

D. If precast designer requires additional design information, precast designer shall contact engineer.

1.6 SUBMITTALS

A. Pile Installation Plan: At least 30 days prior to installation, Contractor shall submit a Pile Installation Plan to the Engineer for approval. Pile Installation Plan shall include the following:

1. List of proposed installation equipment including cranes, driving equipment, jetting equipment, compressors, hammers and pre-drilling equipment. Include manufacturer's data sheets with submittal.

2. Methods to determine hammer energy or stroke in the field for determination of pile capacity. Include the necessary charts and recent calibrations for any pressure measuring equipment and method for monitoring pile advancement.

3. Details of proposed load test equipment and procedures including recent calibrations of jacks and required load cells.

4. Shop drawings of piles indicating fabrication details, reinforcement, dimensions and pick points.

5. Drawings of templates and followers (if permitted).

6. Sequence of driving.

7. Methods and equipment proposed to prevent displacement of piles during placement and compaction of fill within 20 feet of piles.

B. Pile Load Test Reports: The results of which will determine the final pile length for procurement of the remaining production piles.

C. Record of Driving: Within three (3) days of installation, submit a complete report of each pile driven to include:

1. Sizes, lengths, locations, and batters (if any) of piles.

2. Make and type of hammer.

3. Driving energy of each hammer blow.

4. Number of blows per foot of penetration for entire length of pile and set for the last 10 blows.

5. Final tip and butt elevations.

6. Piles requiring drilling and the hole diameters.

1.7 QUALITY ASSURANCE

A. Concrete work shall conform to all requirements of ACI 301 and PCI MNL-116.

B. Manufacture and transportation of prestressed concrete piles shall be by a company having not less than three (3) years' experience in the manufacture of prestressed concrete structural components of equivalent type, size and complexity to those included herein. Upon Engineer's request, the manufacturer shall show successful completion documentation of similar and comparable work.

C. Plant organization and manufacturing procedures shall conform to PCI MNL-116 and plant shall be certified by the PCI Certification Program.

D. Plant Inspection:

1. Plants shall be subject to Engineer's, Owner's, or Owner's Representatives inspection to confirm compliance with the specifications.

2. The Engineer shall be given ample notice before the beginning of work so all of plant facilities involved in production can be inspected. No member shall be manufactured until all facilities are approved.

3. Engineer shall be allowed free access to all parts of the production process premises.

4. Engineer will have the authority to reject materials or workmanship that does not meet contract specifications.

5. Acceptance of any material or finished members by the Engineer shall not prevent them from being rejected later if they are found to be defective. Rejected material and workmanship shall be replaced promptly or made good at the Contractor's expense.

1.8 QUALIFICATIONS

A. Installer: Company specializing in performing the work of this section with minimum five (5) years' documented experience.

B. Design of piles, components and subsequent shop drawings shall be completed by and sealed by a professional engineer registered in the state of the project.

1.9 PRE-INSTALLATION CONFERENCE

A. Convene two (2) weeks prior to commencing pile driving activities.

1.10 SCHEDULING

A. Schedule work under the provisions of Section 01300.

B. Engineer shall be provided with pile installation schedule at the pre-installation conference. Changes to the pile installation schedule shall be submitted to the Engineer as soon as possible.

C. Schedule Work to perform driving during 8:00a.m. and 6:00p.m, unless other arrangements are made with the Owner.

D. Schedule test piles with all necessary parties, including owner, testing agency and engineer.

PART 2 – PRODUCTS

2.1 PILES

A. Piles shall be provided in accordance with the following: ACI 543R – Recommendations for Design, Manufacture and Installation of Concrete Piles, PCI JR 382 – Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling and PCI MNL-116 – Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

B. Piles shall be manufactured by a plant certified by the PCI Certification Program.

2.2 MATERIALS

A. Concrete: Minimum 5,000 psi 28 day strength, Normal Portland cement; aggregates and sand as recommended by pile manufacturer.

B. Tensioning Steel Tendons: AASHTO M 203, Grade 270k, of sufficient strength commensurate with member design.

C. Reinforcing Steel: ASTM A706 Grade 60.

2.3 FABRICATION

A. Pile Points: Hardened steel, hollowed tip to minimize bounce or deflection.

B. Pile Connectors: Fabricated of steel angles, fitted to square pile ends outside dimensions.

C. Shop fabricate pile in maximum practical lengths to meet design requirements.

2.4 SOURCE QUALITY CONTROL

A. Provide shop testing and inspection of piles under provisions of Section 01400.

B. Test sample piles in accordance with PCI MNL-116.

2.5 DRIVING EQUIPMENT

A. Hammers: Piling shall be driven with power hammers of approved make and model, steam or air hammers shall be furnished with boiler or air compressor capacity and hose sizes at least equal to those specified by the hammer manufacturer. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. Power hammers shall be maintained in such condition so length of stroke and blows per minute are obtained as specified by the manufacturer. Driving resistance values computed when these requirements are not met will be considered invalid, and driving operations shall cease until corrective measures are taken. Vibratory pile driving equipment shall not be used. Power hammers shall develop an energy per blow of at least one foot-pound for each pound of pile weight, but not less than 15,000 foot-pounds. Driving conditions may necessitate the use of hammers developing more energy than required minimum, but, for purpose of ascertaining required driving resistance, Contractor will not be required to furnish a hammer having more than a minimum manufacturer's energy rating of 22,400 foot-pounds.

B. Leads: Pile driving rigs shall be equipped with leads constructed in a manner to afford freedom of movement for the hammer and to provide adequate pile support during driving. Vertical axis of leads and hammer shall coincide with the vertical axis of the pile. Leads shall be of sufficient length and rigidity to hold the pile in accurate alignment while being driven. However, the driving rig shall be capable of making minor adjustments in positioning leads, to compensate for minor changes in direction while driving.

C. Followers: The driving of piling by means of followers must be approved by the Engineer prior to implementation.

PART 3 – EXECUTION

3.1 PREPARATION

A. It shall be the Contractor’s responsibility to verify site conditions will support proposed driving equipment.

B. Contractor shall use a driving method at all times, which will not cause damage to nearby structures. No piles shall be driven within 20 feet of concrete less than seven (7) days old unless so directed by the Engineer.

C. Notify adjacent and affected land owners and building occupants with 30 days notice before proceeding with the work.

D. Do not ship piles prior to the completion of a 72 hour (min) curing period and attainment of the required 28-day strength.

3.2 PROTECTION OF PILES DURING DRIVING

A. A structural steel driving head/helmet suitable for the type and size of pile being driven shall be used. It shall adequately hold the pile in proper positioning for driving. It shall be constructed to prevent undue damage to the pile and transmit hammer energy along pile axis. Suitable hammer cushion shall be used above driving head / helmet as necessary to prevent damage to the pile. Do not use wood chips, wood blocks, rope or other material which permits excessive loss of hammer energy. Driving head / helmet shall fit loosely around pile head, enabling pile to rotate slightly without binding.

B. A suitable pile cushion shall also be provided for the top of the pile. It shall be made of a material which will not compress to such an extent the cushioning effect is lost. Pile cushion shall be replaced if, through pile driving, it is compressed to more than one-half original thickness.

3.3 PILE DRIVING

A. Extreme care shall be exercised in the locating and driving of piles so that no other piles, utilities or existing structures are damaged in the process.

B. Plan Driving Objective (PDO): Driving of all piles shall be continuous without interruption until the PDO is obtained. The PDO has these minimum requirements to be obtained during pile driving:

1. The minimum driven length of piles shall be as indicated on the drawings. Test piles shall be 5 feet longer than that specified.

2. The Driving Resistance per pile shall be as stated in this Specification, Section 1.5, Performance Requirements.

C. Drive piles at any time after the concrete has been cured in accordance with PCI MNL-116 and the concrete compressive strength is equal to or greater than the specified 28-day strength.

D. Templates shall be required for all pile driving systems except where fixed leads are utilized.

E. Removal of Obstacles: Unless otherwise permitted, underground obstructions that prevent attainment of the PDO shall be removed or cut-out. Removal or cutting will

be measured and paid for at a price mutually agreed upon by the Owner and Contractor.

F. Practical Refusal: 2.5 times the design bearing capacity with a minimum penetration of 40'-0" below existing grade. When point of refusal is reached during pile driving before attaining PDO, care shall be taken to avoid damaging the pile by overdriving.

G. Jetting: Jetting shall not be used on this project.

H. Drilling / Augering: If conditions warrant the need for pre-drilling or augering prior to driving piles, Contractor shall submit a request with explanation to Engineer for approval.

I. Protection: Piling shall not be subjected to excessive tensile stresses due to the combination of a particular hammer with the given soil conditions, such as may occur when driving a long pile through soft material or when hard driving resistance is encountered at the tip of a long pile. When such damage occurs, the Contractor shall make such changes as necessary to provide undamaged piling in place. If such damage occurs, the Engineer may require:

1. Reduced energy delivered to the pile. This may be reduced stroke, change in cushioning, or a lighter ram.

2. Equivalent energy, but with a heavier or lighter ram with a different stroke.

3. Smaller hammer for the easier initial driving.

4. Jetting may be considered.

J. Delay: When driving is interrupted before final penetration is reached, drive an additional 12 inches before resuming recording or performance data.

K. Back-Driving: In the event uplift of a previously driven pile occurs due to driving of adjacent piles or soil uplift, the pile shall be back-driven to its original penetration.

L. Followers may be used upon approval of the Engineer. Cross sectional area of the follower must be at least 18% of the cross sectional area of the pile. Followers must maintain the alignment of the pile and hammer and must allow the pile to be driven within allowable tolerances.

3.4 TOLERANCES

A. Maximum Variation from Vertical for Plumb Lines: 1 in 48.

B. Maximum Variation from Required Angle for Batter Piles: 1 in 24.

C. Maximum Variation from Pile Cut-Off Elevation: 4 inches, provided specified embedment in pile cap is achieved.

D. Maximum Out-of-Position: 3 inches for any one pile. The sum of any two piles shall not exceed 5 inches.

E. Pile butts shall not be pulled into required location more than 2 inches.

3.5 LOAD CAPACITY

A. Approximate load capacity of all piles shall be determined by evaluation of driving resistance, regardless of the PDO requirements. Driving resistance will be determined by the following formulas:

For Single-Acting Hammers: $DR = \frac{2WH}{S + 0.1}$

For Double-Acting Hammers: $DR = \frac{2(W + AP)H}{S + 0.1}$

Where:
- DR = Driving resistance in tons
- W = Weight of striking part of hammer in tons
- H = Height of fall in feet, 10-feet maximum.
- A = Area of piston in square inches
- P = Pressure at the hammer in tons per square inch
- S = Average penetration in inches per blow for the last 10 to 20 blows

Above formulas are applicable only when hammer has a free fall, head of the pile is not cracked or crushed, penetration is at a uniform rate, and a follower is not used.

3.6 CUTOFFS, SPLICES, AND EXTENSIONS

A. All piling shall be driven to or cut off at the required elevation at a right angle to the axis of the pile. Piling driven below this elevation shall be spliced and extended in accordance with SCDOT standard details.

B. Concrete at the end of pile to be extended shall be cut back a required amount leaving pre-stressed strand exposed. Final cut shall be at right angle to the pile axis. Cutting shall be performed in a manner to avoid spalling or damaging the pile below cut-off elevation. In case of such damage, the pile shall be replaced or damage remedied by further cut back as determined by the Engineer at Contractor's expense. Cutting may be performed with pneumatic tools, saws, or other approved methods. In no case shall explosives be used.

C. Formwork necessary for the extension shall be built, placed, and braced with special care to obtain true alignment and to prevent leakage at the construction joint.

D. Just prior to placing new concrete, the cut area shall be thoroughly wetted and then covered with a thin coating of cement paste.

E. Extensions are not permitted for this project.

3.7 NON-CONFORMING PILES

A. Non-conforming piles are any piles that fail to meet material certification, are driven out of position, are driven below the specified cut-off elevation, or are damaged by reason of internal defects or by improper driving.

B. Non-conforming piles shall be corrected at Contractor's expense by one or more of the following methods, as directed by the Engineer:

1. Extract the pile and replace it with a new pile.

2. Drive a new pile adjacent to the defective pile.

3. Extend footing or cap concrete to embed the pile properly, and make required changes to bar reinforcement steel.

4. Delay the work pending a design analysis. Corrections specified by the Engineer shall be made. Delay will be considered as incidental to the work.

C. Cracks that develop in a pile which do not warrant classifying the pile as defective shall be sealed with an approved epoxy crack sealer placed as directed, at no cost to the Owner. The Engineer will be solely responsible for determining if a pile shall be classified as defective.

3.8 FIELD QUALITY CONTROL

A. Field observation will be performed under provisions of Section 014500, Quality Control.

B. At the Owner's expense, the Special Inspector shall inspect piles prior to installation, conduct all pile testing, and maintain records of blow counts throughout installations. Contractor is responsible for scheduling testing agency for Special Inspection services.

C. Contractor shall be responsible for payment to testing agency if it is the Contractor's fault that Special Inspection services are requested and not needed. Some examples of this are schedule mishaps, equipment malfunction, subcontractor failure to perform, etc. This does not include delays or cancellations due to acts of God or inclement weather.

D. Test piles shall be production piles.

END OF SECTION

SECTION 316244

PILE LOAD TESTS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Pile load testing with documented results.

1.2 RELATED SECTIONS

A. Section 316213 - Concrete Piles.

1.3 REFERENCES (LATEST REVISION)

A. ASTM D 4945 – Standard Test Method for High-Strain Dynamic Testing of Deep Foundations.

1.4 MEASUREMENT AND PAYMENT

A. Test Piles:

1. Accepted test piles required by the plans shall be included in the lump sum price of the project. Payment includes set-up, applying test load, test equipment, monitoring, and reporting results.

2. It is intended that test piles will be production piles.

B. The cost of testing of piles shall be borne by the Owner, included in the scope of services for the special inspector. Owner is not responsible for any additional costs incurred as a result of Contractor's mistakes or unpreparedness for testing procedures.

1.5 SUBMITTALS

A. Equipment and Test Data: Indicate test method and equipment, load type, and calibration equipment.

B. Dynamic Pile Test Report: Following completion, submit to Engineer.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ASTM D 4945.

B. Maintain one (1) copy of document on site during testing.

1.7 QUALIFICATIONS

A. Monitor test pile placement and elevations under direct supervision of a Registered Land Surveyor experienced in design of this work and licensed in the state where the project is located.

B. Testing shall be performed by the agency performing special inspections.

1.8 SEQUENCING

A. Sequence work to allow other excavations and site work during testing.

PART 2 – PRODUCTS

2.1 EQUIPMENT

A. Equipment Type, Load Carrying Device, Load, and Instrumentation: Conform to ASTM D 4945 and use same type as will be used for installation of all other piles.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify site conditions will support loads and equipment necessary for testing purposes. Submit documents to support verification.

3.2 PREPARATION

A. Establish stable working elevation for test equipment.

3.3 TESTING

A. Following installation of test piles, allow test piles to sit idle for 7 days for set-up. Following set-up, perform Dynamic Load Testing using a Pile Dynamic Analyzer (PDA).

B. Load test the following:

1. WWTP Basins/Building: Test (2) piles prior to installation of production piles. It is assumed that test piles will also be production piles and should be located at opposite ends of the building/basin structure. Contractor may propose location to Engineer for approval.

   Test (4) additional piles throughout duration of installation to ensure consistency and confirm results.

C. Load test results should confirm a minimum of two times the design service load of the pile. If tested piles do not conform to requirements, static load test or testing of additional piles may be required.

D. Test results shall be provided to the Engineer within three (3) business days of completion of the testing.

3.4 FIELD QUALITY CONTROL

A. Field observation and monitoring of testing will be performed by special inspector and Engineer.

B. Document test equipment used, method of calibration and recording, test results, and recommendations or modification of piling method used.

C. Accurately record actual dimensions and locations of tested piles and movement or distortion caused by testing.

3.5 EQUIPMENT REMOVAL

A. Remove test equipment from site following completion of test procedures.

END OF SECTION

INDEX TO

SECTION 32 11 23

AGGREGATE BASE COURSE

SECTION 32 11 23

AGGREGATE BASE COURSE

PART 1 – GENERAL

1.01 SECTION INCLUDES

Aggregate base course.

1.02 RELATED SECTIONS

A. Section 01400 - Quality Control.

B. Section 02204 - Earthwork

C. Section 02512 - Asphaltic Concrete Binder/Surface Courses: Binder and finish asphalt courses.

1.03 MEASUREMENT AND PAYMENT

Aggregate Base Course: Payment will be included in the contract lump sum price. Payment will include supplying all material, labor, and equipment, stockpiling, scarifying substrate surface, placing where required, and compacting.

1.04 REFERENCES (LATEST REVISION)

A. ASTM C 131 – Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Lost Angeles Machine.

B. ASTM D 1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort.

C. ASTM D 2922 – Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

D. ASTM D 6938 – In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

E. ASTM D 3740 – Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction.

F. ASTM E 329 – Agencies Engaged in Construction Inspection and/or Testing.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

B. Source Quality Control Measures:

1. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

2. Final approval of aggregate material will be based on test results of installed materials.

3. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

1.06 TESTING

A. Laboratory tests for moisture density relationship for fill materials shall be in accordance with ASTM D 1557, (Modified Proctor).

B. In place density tests in accordance with ASTM D 1556 or ASTM D 2922.

C. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

D. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48 hours notice prior to taking any tests.

E. Owner shall select and engage the Testing Laboratory. Testing Laboratory shall be responsible to the Owner and Owner's Engineer. Payment for laboratory and all tests shall be by the Owner, except Owner specifically reserves the right to deduct from Contractor's payment, expenses and charges of Testing Laboratory when:

1. Contractor gives notice the work is ready for inspection and testing, and fails to be ready for the test, and/or

2. Testing of the Contractor's work, products, or materials fail, and retesting is required, and/or

3. Contractor abuses the services or interferes with the work of the testing laboratory in the conduct of this work.

F. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

1.07 SUBMITTALS

A. Informational Submittals

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

2. Certified results of in-place density tests from independent testing agency.

PART 2 – PRODUCTS

2.01 MATERIALS

Aggregate shall consist of processed and blended crushed stone. Aggregates shall be free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material and shall be durable and sound. Coarse aggregate shall have a percentage of wear not to exceed 65% after 500 revolutions as determined by ASTM C 131. Aggregate shall meet applicable requirements of Section 305.2 in the South Carolina Department of Transportation Standard 2007 Specifications for Highway Construction. Material shall meet the following gradation and other requirements:

Granite Stone or Recycled Concrete	
Sieve Size	Percent by Weight Passing
2”	100
1-1/2”	95 - 100
1”	70 - 100
1/2”	48 - 75
# 4	30 - 60
# 30	11 - 30
#200	0 - 12
Liquid Limit	0 to 25
Plasticity Index	0 to 6

Marine Limestone	
Sieve Size	Percent by Weight Passing
2”	100
1-1/2”	95 - 100
1”	70 - 100
1/2”	50 - 85
# 4	30 - 60
# 30	17 - 38
#200	0 - 20
Liquid Limit	0 to 25
Plasticity Index	0 to 6

2.02 EQUIPMENT

A. Equipment shall be in accordance with the South Carolina Department of Transportation Standard 2007 Specifications for Highway Construction.

B. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify subbase has been tested, is dry, and slopes and elevations are correct.

B. ON SITE OBSERVATIONS OF WORK: The Owner's Representative or Engineer will have the right to require any portion of the work be completed in their presence and if the work is covered up after such instruction, it shall be exposed by the Contractor for observation at no additional cost to the Owner. However, if the Contractor notifies the Owner such work is scheduled, and the Owner or Engineer fails to appear within 72 hours, the Contractor may proceed. All work completed and materials furnished shall be subject to review by the Owner, Engineer or Project Representative. Improper work shall be reconstructed, and all materials, which do not conform to the requirements of the specifications, shall be removed from the work upon notice being received from the Engineer for the rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

C. Contractor shall give the Owner, Project Engineer or Project Representative a minimum of 72 hours notice for all required observations or tests.

3.02 PREPARATION

A. Subbase shall be graded and shaped conforming to the lines, grades, and cross sections required and cleaned of all foreign substances prior to constructing base course. Do not place base on soft, muddy or frozen surfaces. Correct irregularities in subbase slope and elevation by scarifying, reshaping, and recompacting.

B. At the time of base course construction, subbase shall contain no frozen material.

C. Surface of subbase shall be checked by the Engineer or Project Representative for adequate compaction and surface tolerances. Ruts or soft yielding spots appearing in areas of subbase course having inadequate compaction, and areas not smooth or which vary in elevation more than 3/8-inch above or below required grade established on the plans, shall be corrected to the satisfaction of the Engineer or Project Representative. Base material shall not be placed until subbase has been properly prepared and test results have so indicated.

D. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

E. Hauling:

1. Do not haul over surfacing in process of construction.

2. Loads: Of uniform capacity.

3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

3.03 AGGREGATE PLACEMENT

A. Aggregate shall be placed in accordance with South Carolina Department of 2007 Transportation Standard Specifications for Highway Construction Section 305 and in accordance with these specifications.

B. Maximum lift thickness of Aggregate Base Course shall be six (6) inches. Maximum lift thickness of Gravel Surfacing shall be nine (9) inches. Place and compact each lift to required density before succeeding lift is placed.

C. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.

D. Produce even distribution of material upon roadway or prepared surface without segregation. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

E. Level and contour surfaces to elevations and slopes indicated on the Drawings.

F. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

G. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

H. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

I. While at optimum moisture (± 1-1/2%), compact base course with rollers capable of obtaining required density. Vibratory, flatwheel, and other rollers accepted by the Engineer may be used to obtain required compaction. Rolling shall continue until base is compacted to 100% of the modified Proctor maximum laboratory dry density as determined by ASTM D 1557. In-place density of the compacted base shall be determined in accordance with ASTM D 2922.

J. Base shall be allowed to cure at least 15 days after the acceptable completion tests are achieved before paving.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with an acceptable 10-foot straight edge.

B. Scheduled Compacted Thickness: Within 3/8 inch.

C. Variation from Design Elevation: Within 3/8 inch.

D. Depth measurements for compacted thickness shall be made by test holes through the base course. Where base course is deficient, correct such areas by scarifying, adding base material and recompacting as directed by the Engineer.

3.05 FIELD QUALITY CONTROL

A. Density and moisture testing will be performed in accordance with ASTM D 1557, ASTM D 2922, and ASTM D 6938.

B. See Table below for minimum sampling and testing requirements for aggregate base course and surfacing:

Minimum Sampling and Testing Requirements			
Property	**Test Method**	**Frequency**	**Sampling Point**
Gradation	AASHTO T11 and AASHTOT27	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	AASHTO T180, Method D	One test for every aggregate grading produced	Production output of stockpile
In-place Density and Moisture Content	AASHTO T310 and AASHTO T265 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests:

Base Density and Thickness - One test per 5,000 square feet.

END OF SECTION

INDEX TO

SECTION 32 12 16SC

ASPHALT PAVING

SECTION 32 12 16SC

ASPHALT PAVING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Surface Course

B. Binder Course

1.02 RELATED SECTIONS

A. Section 01 45 00 – Quality Control

B. Section 31 23 13 – Subgrade Preparation

C. Section 31 23 23 – Fill and Backfill

D. Section 32 11 23 – Aggregate Base Courses

1.03 OMITTED

1.04 REFERENCES (LATEST REVISION)

A. ASTM D 946 – Penetration–Graded Asphalt–Cement for Use in Pavement Construction.

B. ASTM E 329 – Agencies Engaged in Construction Inspection and/or Testing.

C. ASTM D 3740 – Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction.

D. ASTM D 2726 – Bulk Specific Gravity and Density of Non–Absorptive Compacted Bituminous Mixtures.

E. ASTM D 2950 – Density of Bituminous Concrete in Place by Nuclear Methods.

F. ASTM D 1188 – Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.

G. ASTM D 1754 – Effect of Heat and Air on Asphaltic Materials (Thin–film Oven Test).

1.05 QUALITY ASSURANCE

A. Perform work in accordance with South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

B. Mixing Plant: Conform to South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not place asphalt mixture when ambient air temperature is less than that indicated in the Table nor when the surface is wet or frozen.

Lift Thickness	Min. Air Temperature, Degrees F.
1" or Less	55
1.1" to 2"	45
2.1" to 3"	40
3.1" to 4.5"	35

B. Mixture shall be delivered to the spreader at a temperature between 250 degrees F and 325 degrees F.

1.07 GUARANTEE

A. Contractor shall guarantee the quality of materials, equipment, and workmanship for a period of 12 months after acceptance. Defects discovered during this period shall be repaired by the Contractor at no cost to the Owner.

1.08 TESTING

A. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

B. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48 hours notice prior to taking any tests.

C. Owner shall select and engage the testing laboratory. Testing laboratory shall be responsible to the Owner and Owner's Engineer. Payment for laboratory and all tests shall be by the Owner, except Owner specifically reserves the right to deduct from Contractor's payment, expenses and charges of testing laboratory when:

1. Contractor gives notice the work is ready for inspection and testing, and fails to be ready for the test, and/or

2. Testing of the Contractor's work, products or materials fail, and retesting is required, and/or

3. Contractor abuses the services or interferes with the work of the testing laboratory in the conduct of this work.

D. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

PART 2 – PRODUCTS

2.01 TACK COAT

A. Shall consist of asphalt binder (asphalt cement) or emulsified asphalt, conforming to Section 401 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction. Asphalt binder shall be PG64–22. The acceptable grades of emulsified asphalt are RS–1, MS–1, MS–2, HFMS–1, HFMS–2, SS–1, CRS–1, CRS–2, CMS–2, and CSS–1.

2.02 ASPHALT BINDER AND ADDITIVES

A. Shall be PG64–22 and conform to Section 401 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

B. Anti–Stripping: Shall conform to requirements of Section 401 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

2.03 AGGREGATES

A. General: Mineral aggregate shall be composed of fine aggregate or a combination of fine and coarse aggregate. Coarse aggregate shall be that portion of the material retained on a No. 4 sieve.

Fine aggregate shall be considered that portion passing the No. 200 sieve. Fine aggregate, coarse aggregate, and any additives in combination with the specified percentage of asphalt cement shall meet the requirements of tests specified, before acceptance may be given for their individual use. Marine (Fossiliferous) limestone shall not be used.

B. Fine Aggregate: Shall conform to the requirements of Section 401 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.

C. Coarse Aggregate: Shall be granite stone and conform to the requirements of Section 401 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

D. Surface Course: The surface course shall consist of fine and coarse aggregate and mineral filler uniformly mixed with hot asphalt binder in an acceptable mixing plant. The plant shall conform to South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction. The gradations, asphalt content and air voids shall be the following:

TYPE C	
Square Sieve	% Passing
3/4 inch	100
1/2 inch	97 – 100
3/8 inch	83 – 100
No. 4	58 – 80
No. 8	42 – 62
No. 30	20 – 40
No. 100	8 – 20
No. 200	3 – 9
% Asphalt Binder	5.0 – 6.8
Air Voids, %	3.5 – 4.5

E. Intermediate or Binder Course: The mineral aggregates and asphalt binder shall be combined in such proportions the composition by weight of the finished mixture shall be within the following range limits:

TYPE B	
Sieve Designation	Percentage by Weight Passing
1 inch	100
3/4 inch	90 – 100
1/2 inch	75 – 90
3/8 inch	64 – 80
No. 4	38 – 54
No. 8	22 – 36
No. 30	8 – 22
No. 100	3 – 10
No. 200	2 – 8
% Asphalt Binder	4 – 6
Air Voids, %	– 4.5

2.04 SOURCE QUALITY CONTROL AND TESTS

A. Section 01 45 00 – Quality Control.

B. Submit proposed mix design for review prior to beginning of work.

C. Test samples in accordance with the requirements of these specifications.

PART 3 – EXECUTION

3.01 EXAMINATION

A. On–Site Observations: Owner's Representative or Engineer will have the right to require any portion of work be completed in their presence. If work is covered up after such instruction, it shall be exposed by the Contractor for observation at no additional cost to Owner. However, if Contractor notifies Engineer such work is scheduled, and Engineer fails to appear within 48 hours, the Contractor may proceed. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. Improper work shall be reconstructed. All materials, which do not conform to requirements of specifications, shall be removed from the work upon notice being received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

Contractor shall give the Owner, Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

B. Contractor shall verify base has been tested, is dry, and slopes and elevations are correct.

3.02 PREPARATION

A. Apply tack coat in accordance with Section 401 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction. Rate of application shall be 0.05 to 0.15 gallons per square yard of surface.

B. Work shall be planned so no more tack coat than is necessary for the day's operation is placed on the surface. All traffic not essential to the work should be kept off the tack coat.

C. Apply tack coat to contact surfaces of curbs and gutters. Apply in manner so exposed curb or gutter surfaces are not stained.

D. Coat surfaces of manhole frames and inlet frames with oil to prevent bond with asphalt pavement. Do <u>not</u> tack coat these surfaces.

3.03 PLACEMENT

A. Construction shall be in accordance with Sections 401, 402, and 403 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

B. Asphaltic concrete shall not be placed on a wet or frozen surface.

C. Compaction shall commence as soon as possible after the mixture has been spread to the desired thickness. Compaction shall be continuous and uniform over the entire surface. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks. Compaction rolling shall be complete before material temperature drops below 175° F.

D. Areas of pavement with deficient thickness or density shall be removed and replaced at no additional cost to the Owner.

3.04 TOLERANCES

A. General: All paving shall be subject to visual and straightedge evaluation during construction operations and thereafter prior to final acceptance. A 10–foot straightedge shall be maintained in the vicinity of the paving operation at all times for the purpose of measuring surface irregularities on all paving courses. The straightedge and labor for its use shall be provided by the Contractor. The surface of all courses shall be checked with the straightedge as necessary to detect surface irregularities. Irregularities such as rippling, tearing or pulling, which in the judgment of the Engineer indicate a continuing problem in equipment, mixture or operating technique, will not be permitted to recur. The paving operation shall be stopped until appropriate steps are taken by the Contractor to correct the problem.

B. Flatness: All irregularities in excess of 1/8 inch in 10 feet for surface courses and 1/4 inch in 10 feet for intermediate courses shall be corrected.

C. Variation from Design Elevation:

1. General Paving: Less than 1/4 inch.

2. Accessible Routes: Shall not exceed 1/4 inch. However, accessible routes shall not exceed maximum ADA allowable slopes. Contractor shall remove and replace any and all portions of the accessible route that exceed maximum ADA allowable slopes.

D. Scheduled Compacted Thickness: Within 1/4 inch per lift.

E. Pavement Deficient in Thickness: When measurement of any core indicates the pavement is deficient in thickness, additional cores will be drilled 10 feet either side of the deficient core along the centerline of the lane until the cores indicate the thickness conforms to the above specified requirements. A core indicating thickness deficiencies is considered a failed test. Pavement deficient in thickness shall be removed and replaced with the appropriate thickness of materials. If the Contractor believes the cores and measurements taken are not sufficient to indicate fairly the actual thickness of the pavement, additional cores and measurements will be taken, provided the Contractor will bear the

extra cost of drilling the cores and filling the holes in the roadway as directed.

3.05 FIELD QUALITY CONTROL

A. Acceptance of the in–place density of the binder and surface courses shall be in accordance with the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

B. Density Testing: Performed in accordance with ASTM D–2726 and ASTM D–2950. Core samples for each day's operation shall be taken, tested and results reported to the Engineer the following day. The areas sampled shall be properly restored by the Contractor at no additional cost to the Owner. Nuclear gauge tests shall be taken during the asphaltic concrete placement.

1. The pavement core and nuclear gauge densities shall range between 94% and 96% of the theoretical maximum laboratory density.

C. Temperature:

1. Asphaltic concrete shall not exceed 325 degrees F at any time.

2. Asphaltic concrete shall not be placed once the temperature of the mix falls below 250 degrees F or the delivered temperature is more than 15 degrees F below the batch plant's delivery ticket.

3. Temperature at time of loading shall be recorded on the truck delivery ticket.

D. Frequency of Tests:

1. Asphaltic Concrete – One test for each 250 tons placed.

a. Asphalt extraction and gradation test.

b. Core Sample

2. Field determination of density by nuclear method every 5,000 square feet during construction of the asphaltic concrete binder/surface course.

END OF SECTION

INDEX TO

SECTION 32 31 18

RAIL FENCES & GATES

SECTION 32 31 18

RAIL FENCES & GATES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section consists of the requirements regarding rail fences and gates.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise required by city and/or county ordinances, fences and gates shall be as shown on the details.

B. All wood materials shall be treated wood, or wood of a natural resistance to decay. Materials shall be free from loose knows, cracks, and other imperfections.

2.02 RAILS

A. 3-rail system shall be used.

2.03 POSTS

A. Posts shall be 6-inch by 6-inch. Any deviations shall be approved by the Engineer.

B. 3-rail posts shall be approximately 48 inches in height. Any deviations shall be approved by the Engineer.

C. Posts shall be buried 36-inches into the ground.

2.04 GATES

A. In general, gates shall be tubular steel frame or heavy duty livestock or farm style, if approved by the owner. If field conditions dictate a difference gate type, consult with Engineer. Gates shall be black (minimum of 2 coats of epoxy paint).

B. Gates for rail fences shall be Man Gates or Truck Gates.

C. Man Gate openings shall be a minimum of 3 feet wide.

D. Truck Gates openings shall be at least 18 feet wide.

E. Gates shall be a minimum of 16 gauge (1 ¾" or heavier), high tensile 50,000 psi tubular steel, if tubular steel.

F. Fittings and hardware shall be galvanized.

G. Hinge system shall be as per gate manufacturer's recommendations.

H. Gates shall be powder coated or equivalent if tubular. Paint black – minimum of 2 coats recommended coating.

I. Acceptable tubular gates include Mulberry Farm Gates, Renze Feed Victory Gate, Hutchinson Inc. Tubular Livestock Gate, or equivalent.

J. In general, gate shall be wood similar to the rail fence using galvanized hardware for hinges and latching.

PART 3 EXECUTION

3.01 LAYOUT OF WORK

A. Under no circumstance shall a fence or gate post be located within LAS (Land Application System) area.

B. Gate locations shall be approved by Owner prior to installation.

3.02 INSTALLATION OF POSTS

A. Posts shall be set true to line and grade.

B. Line posts require concrete footings at least at 40-foot intervals. Footings shall be in accordance with 3.02C.

C. Gate, corner, turn, and end posts do require 16-inch diameter concrete footings extending at least 36-inches into undisturbed natural ground or properly compacted fill.

3.03 INSTALLATION OF GATES

A. Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation.

B. Man Gates:

1. Shall be installed on all enclosed or fenced-in areas.
2. Shall be configured to allow Owner to enter the enclosed area, to perform inspections, and exit to the opposite side of the enclosed area, if necessary.
3. Once gate is installed, coordinate with Owner on lock installation.

C. Truck Gates:

1. Shall be installed at the locations shown on the plans.
2. Shall open/close in direction as directed by the Owner.
3. Once gate is installed, coordinate with Owner on lock installation.

END OF SECTION

INDEX TO

SECTION 32 92 00

TURF AND GRASSES

SECTION 32 92 00

TURF AND GRASSES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Seeding, planting grass, and fertilizing graded areas behind the structures, pipeline rights–of–way, roadway shoulders, slopes and other disturbed areas.

B. Seed protection.

C. Maintaining seeded areas until final acceptance.

1.02 RELATED WORK

A. Civil and Landscape plans and specifications.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed in original containers showing analysis of seed mixture, percentage of pure seed, year of production, net weight, date of packaging, and location of packaging. Damaged packages are not acceptable. Store in cool, dry locations away from contaminants.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer. Damaged bags are not acceptable. Store in cool, dry locations away from contaminants.

C. Deliver sod on pallets.

D. All material shall be acceptable to Engineer prior to use.

1.04 PLANTING DATES

A. This specification provides for establishment of a permanent grass cover between the dates of March 1 and September 30. If finished earth grades are not completed in time to permit planting and establishment of permanent grass during the favorable season between dates specified above unless otherwise accepted, Contractor will be required to plant a temporary cover to protect new graded areas from erosion and to keep windborne dust to a minimum. The temporary cover shall be planted between October 1 and February 28 unless otherwise permitted.

PART 2 – PRODUCTS

A. Contractor shall submit source and species certification documents to Engineer and Owner's Representative for review prior to installation. Supply complete information on all analysis/test methodologies and results; laboratory certifications, manufacturer's specifications, and agency approvals to the Landscape Architect/Project Engineer prior to placement of soil mixtures. In

addition, provide the Landscape Architect/Project Engineer with thoroughly mixed sample of soil mixes for acceptance prior to placement. Landscape Contractor shall make modifications and improvements to soil mixes deemed necessary by the soil analysis to meet requirements specified here in before, and to ensure proper growing medium for plant material.

2.01 SEED

A. All seed shall conform to State Laws and requirements and regulations of the State Department of Agriculture.

B. The varieties of seed, as specified in Section 2.2, shall be individually packaged or bagged, and tagged to show name of seed, net weight, origin, germination, lot number, and other information required by the State Department of Agriculture.

C. Engineer reserves the right to test, reject, or accept all seed before seeding.

2.02 SEEDING SCHEDULE

A.

SEED	RATE	PLANTING DATES
Bermuda	15–lbs/acre	March 1 – September 30
Brown top millet	10–lbs/acre	
Rye	40-lbs/acre	

2.03 FERTILIZER

A. Commercial fertilizer of accepted type, conforming to State fertilizer laws at the rate as recommended by soils test.

2.04 LIME

A. Agricultural grade, ground limestone at the rate as recommended by soils test.

2.05 SPRIG

A. Healthy living stems, stolons, or rhizomes and attached roots of locally adapted grass without adhering soil, including two to three nodes and from 4 to 6 inches long. Obtain from heavy, dense certified sod. Provide sprigs which have been grown under climatic conditions similar to those in the locality of project. Coordinate harvesting and planting operations to prevent exposure of sprigs to the sun for more than 30 minutes before covering and moistening. Sprigs showing signs of wilt, mold, containing weeds, or other detrimental material or are heat damaged will be rejected.

B. Varieties of sprig, as specified in section 2.6, shall be individually packaged or bagged, and tagged to show name of sprig, net weight, origin, and other information required by the State Department of Agriculture.

C. Sprigs shall be pure to variety specified and shall be free of other grass species, weeds or foreign matter.

D. Sprigs shall be harvested by digging (not collected above soil level), shredding

sod, rototilling sod and raking, vericutting, or with a sprig harvester. Sprigs shall consist of mostly rhizomes and crowns with only a few green leaves.

2.06 SPRIGGING SCHEDULE

A.

SPRIG	RATE	PLANTING DATES
'Tifsport' Bermuda	1,000 bushels/acre (Maximum 12 week grow-in)	April 1 – August 31
Stabilize site with temporary grass seed		September 1 – March 31 (See section 2.2)

B. In areas where existing grass is to be matched, Contractor shall sprig at the rate and dates recommended by sprig distributor.

2.07 SOD

A. Sod shall be premium grade, densely rooted, good quality grass of the species and certified variety as shown on the plans, free from noxious weeds with no surface soil being visible. The sod shall be obtained from areas where the soil is reasonably fertile. Sod of specified species shall be grown from seed or sprig with not less than 95 percent germination, 85 percent pure seed, and not more than 0.5 percent weed seed. The sod shall be machine cut to a uniform soil thickness that shall contain practically all of the dense root system and not be less than 1–inch thick.

B. Before cutting, sod shall be mowed to a height of not less that 1–1/2-inches or more than 2-inches. Sod shall be cut in minimum uniform widths of 12-inches and lengths of 24 inches.

C. Sod shall be delivered to site in a fresh, moist condition with healthy green foliage. It shall be unloaded from delivery trucks on pallets or in rolls and placed in final position within 24 hours of delivery. Sod shall be protected from wind and sun and shall not be allowed to dry out before planting.

D. Sod shall be strong enough to support its own weight and retain its size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.

2.08 ACCESSORIES

A. Straw Mulch: Oat or wheat straw, reasonably free from weeds, foreign matter detrimental to plant life, and in dry condition.

B. Excelsior Mulch: Excelsior mulch shall consist of wood fibers cut from sound, green timber. The average length of fibers shall be 4 to 6 inches. Cut shall be made in such a manner as to provide maximum strength of fiber, but at a slight angle to natural grain of the wood to cause splintering of fibers when weathering in order to provide adherence to each other and to soil.

C. Wood cellulose fiber shall be made from wood chip particles manufactured particularly for discharging uniformly on the ground surface when dispersed by a hydraulic water sprayer. It shall remain in uniform suspension in water under agitation and blend with grass seed and fertilizer to form a homogenous slurry. Mulch fibers shall intertwine physically to form a strong moisture holding mat on the ground surface and allow rainfall to percolate into underlying soil. The mulch shall be heat processed to contain no germination or growth-inhibiting factors. It shall be dyed (non-toxic) an appropriate color to facilitate metering of material.

2.09 TOPSOIL

A. Topsoil shall be fertile, friable natural loam capable of sustaining vigorous plant growth. It shall be free of any admixture of subsoil, stones over 1-inch diameter, clods of hard earth, plants, roots, sticks or other extraneous material. It shall not be excessively acid or alkaline.

2.10 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer will review all products before they are ordered.

PART 3 – EXECUTION

3.01 PREPARATION

A. Areas to be seeded shall be made smooth and uniform and shall conform to the finished grade indicated on plans.

B. Remove all foreign materials, plants, roots, stones, and debris from surfaces to be seeded.

C. Grassing areas, if not loose, shall be loosened to a minimum depth of 3 inches before fertilizer, seed or sod is applied.

D. Amendments to soils shall be incorporated into loosened 3-inch top soil layer as recommended by soils tests.

E. Existing topsoil shall be stripped and stockpiled for future use in an area approved by the Owner. Contractor shall spread topsoil in all areas to have turf or grass. Contractor shall provide additional topsoil as needed at no additional cost.

F. Contractor shall provide Topsoil Analysis Tests performed by a State Agricultural Experiment Station, Soil and Water Conservation District, State University, or other qualified private testing laboratory, as acceptable to Landscape Architect/Engineer. Soils test shall identify existing pH and nutrient levels, as well as recommended adjustments based on the type of grass to be installed.

3.02 STAND OF GRASS

A. Before acceptance of seeding, sodding, or sprigging is performed for the establishment of permanent vegetation, Contractor will be required to produce a satisfactory stand of perennial grass whose root system shall be developed

sufficiently to survive dry periods and winter weather and be capable of re-establishment in spring.

B. Before acceptance of seeding is performed for the establishment of temporary vegetation, Contractor will be required to produce a stand of grass sufficient to control erosion for a given area and length of time before the next phase of construction or establishment of permanent vegetation is to commence.

3.03 SEEDING AND SPRIGGING DATES

A. Seeding and sprigging shall be performed during periods and at rates specified in their respective schedules. Seeding and sprigging work may, at discretion of Contractor, be performed throughout the year using schedule prescribed for given period. Seeding and sprigging work shall not be conducted when the ground is frozen or excessively wet. Contractor will be required to produce a satisfactory stand of grass regardless of the period of year work is performed.

3.04 APPLYING LIME AND FERTILIZER

A. Following advance preparation and placing selected material for shoulders and slopes, lime and fertilizer, if called for based on soil tests, shall be spread uniformly over the designated areas, and shall be thoroughly mixed with the soil to a depth of approximately 2 inches. Fertilizer and lime shall be applied at the rate recommended by required soils test. Unless otherwise provided, lime will not be applied for temporary seeding. In all cases where practicable, acceptable mechanical spreaders shall be used for spreading fertilizer. On steep slopes subject to slides and inaccessible to power equipment, the slopes shall be adequately scarified. Fertilizer may be applied on steep slopes by hydraulic methods as a mixture of fertilizer and seed. When fertilizer is applied with combination seed and fertilizer drills, no further incorporation will be necessary. The fertilizer and seed shall be applied together when Wood Cellulose Fiber Mulch is used. Any stones larger than 2-1/2 inches in any dimension, larger clods, roots, or other debris brought to the surface shall be removed.

3.05 SEEDING

A. Seed shall be sown within 24 hours following application of fertilizer and lime and preparation of the seedbed as specified in Section 3.4. Seed shall be uniformly sown at rate specified by the use of acceptable mechanical seed drills. Rotary hand seeders, power sprayers or other satisfactory equipment may be used on steep slopes or on other areas inaccessible to seed drills.

B. Seeds shall be covered and lightly compacted by means of cultipacker or light roller if the drill does not perform this operation. On slopes inaccessible to compaction equipment, the seed shall be covered by dragging spiked chains, by light harrowing or by other satisfactory methods.

C. Apply water with fine spray immediately after each area has been sown.

D. Do not sow seed when ground is too dry, during windy periods or immediately following a rain.

E. If permitted by the special provisions, wood cellulose fiber mulch or excelsior fiber mulch may be used.

3.06 SEED PROTECTION (STRAW MULCH)

A. All seeded areas seeded with permanent grasses shall be uniformly mulched in a continuous blanket immediately following seeding and compacting operations, using at least 2 tons of straw per acre.

3.07 SEED PROTECTION (EXCELSIOR MULCH)

A. Seed shall be sown as specified in Section 3.5. Within 24 hours after covering of seed, excelsior mulch shall be uniformly applied at the rate of 2 tons per acre. The mulch may be applied hydraulically or by other acceptable methods. Should the mulch be placed in a dry condition, it shall be thoroughly wetted immediately after placing. Engineer may require light rolling of the mulch to form a tight mat.

3.08 SEED PROTECTION (WOOD CELLULOSE FIBER MULCH)

A. After the lime has been applied and ground prepared as specified in Section 3.4, wood cellulose fiber mulch shall be applied at a rate of 1,500 pounds per acre in a mixture of seed and fertilizer. Hydraulic equipment shall be used for application of fertilizer, seed, and slurry of the prepared wood pulp. This equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry of the specified amount of fiber, fertilizer, seed, and water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles which will provide an even distribution of slurry on various areas to be seeded. The slurry tank shall have a minimum capacity of 1,000 gallons.

Seed, fertilizer, wood pulp mulch, and water shall all be combined into the slurry tank for distribution of all ingredients in one operation by hydraulic seeding method specified herein. Materials shall be combined in a manner recommended by the manufacturer. The slurry mixture shall be regulated so amounts and rates of application shall result in a uniform application of all materials at rates not less than amount specified. Using the color of wood pulp as a guide, equipment operator shall spray prepared seedbed with a uniform visible coat. The slurry shall be applied in a sweeping motion, in an arched stream to fall like rain, allowing wood fibers to build upon each other until an even coat is achieved.

3.09 SPRIGGING

A. Sprigs shall be placed at the date and rates as shown in section 2.6. The sprigging method shall be by broadcast sprigging, hydroplanting or row planter. Sprigging procedure shall ensure even coverage.

B. Sprigs applied by broadcast over the site with a distributor or hydroseeder shall be planted at the rates listed in section 2.6. Cover broadcast sprigs with straw mulch immediately after broadcast and water in immediately (within 2 hours).

C. Sprigs installed by row planter creating a narrow furrow that covers 50 to 80% of the sprig with soil may use less sprig material. Rate shall be as recommended by sprig supplier to provide a solid stand of turf within the time required in Section 2.6. Water in immediately (within 1 hour).

3.10 SODDING

A. Sod shall be placed between March 1st and December 1st. However, if sod is to be placed during periods of temperatures over 90 degrees F., the Contractor shall take extra care for quick placement of sod with adequate, consistent watering necessary to ensure sod thrives as planted.

B. Sod shall be placed within 24 hours of cutting.

C. Place top elevation of sod 1/2 inch below adjoining paving or curbs.

D. All areas to be sodded shall be brought to the proper line grade or cross section as was existing prior to construction. Sod shall be placed so, upon completion, edges of sodded areas will be smooth and will conform to the proposed finished grade. Sod shall be laid smooth, edge to edge, with staggered joints. Sod shall be immediately pressed firmly into contact with the sod bed by tamping or rolling, to eliminate any air pockets. A true and even surface shall be provided, to insure knitting without displacement of the sod or deformation of the sodded areas surfaces. Do not stretch or overlap sod pieces. Following compaction, screened soil of good quality shall be used to fill all cracks. Excess soil shall be worked into the grass with rakes or other suitable equipment. On slopes steeper than 3 to 1, sod shall be fastened in place with suitable wood or metal pins to hold the sod in place. Any damage by erosion or other causes occurring after completion of grading operations shall be repaired, before commencing with the sodding operations.

E. Immediately before sodding, moisten topsoil with a fine spray to a minimum 1-inch depth. Sod shall not be laid on dry or powdery soil.

F. Sod shall be moist when laid and placed on moist ground. The sod shall be carefully placed by hand, beginning at the toe of slopes and working upwards. The length of strips shall be at right angles to flow of surface water. All joints shall be tightly butted and end joints shall be staggered at least 12 inches. Sod shall be immediately pressed firmly into the ground by tamping or rolling. Fill all joints between strips with fine screened soil. Sod on slopes shall be pegged with sod pegs to prevent movement.

G. Within two hours after sod has been placed, thoroughly water to a minimum depth of 4-inches. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove depressions and irregularities. Roll sodded areas with a roller not exceeding 150 lbs. per foot of roller width.

PART 4 – MAINTENANCE, WARRANTY AND ACCEPTANCE

4.01 MAINTENANCE

A. Maintain grassed surfaces until final acceptance.

B. Maintenance shall consist of providing protection against traffic, watering to ensure uniform seed germination and to keep surface of soil damp, and repairing any areas damaged as a result of construction operations or erosion. Maintenance shall also include, but is not limited to, watering, weeding, cultivating, removal of dead material, lawn mowing, fertilizing, and other necessary operations.

C. The Contractor shall maintain all proposed plantings until the date of substantial completion issued by the Owner.

4.02 WARRANTY

A. All grassed areas shall be guaranteed by Contractor to be alive and healthy during the warranty period as issued by the Owner. A final walk through with the Owner shall be conducted at end of warranty period to determine if any areas require replanting. At end of warranty period, sod shall show evidence of rooting to underlying soil and shall have no competitive weed growth from either the sod or from between sod joints.

B. Any grassed area which is dead or not showing satisfactory growth shall be replaced at Contractor's expense at the end of warranty period. All replacement shall be of original quality. Replacement required because of vandalism, excessive use, or other causes beyond the control of Contractor are not part of this contract.

4.03 ACCEPTANCE

A. Before acceptance of seeding performed for the establishment of permanent vegetation, Contractor will be required to produce a satisfactory stand of perennial grass whose root system shall be developed sufficiently to survive dry periods and winter weather and be capable of reestablishment in spring.

B. A minimum coverage of 90% density over 100% of the disturbed area is required for seeded areas before project acceptance. Sprig and sod areas shall have 95% coverage over 100% of the disturbed area prior project acceptance.

END OF SECTION

INDEX TO

SECTION 33 05 01.03

DUCTILE IRON PIPE

SECTION 33 05 01.03

DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies ductile iron pipe, ductile fittings and gaskets.

B. DEFINITION:

Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A21.14	Ductile-Iron Fittings 3 In. Through 24 In., for Gas
ANSI A21.52	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Gas
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A716	Ductile-Iron Culvert Pipe
AWWA C104 (ANSI A21.4)	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile-Iron Pipe Systems

Reference	Title
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111 (ANSI A21.11)	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115 (ANSI A21.15)	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges
AWWA C150 (ANSI A21.50)	Thickness Design of Ductile-Iron Pipe
AWWA C151 (ANSI A21.51)	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153 (ANSI A21.53)	Ductile-Iron Compact Fittings, 3 In. Through 12 In. for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Type Joints

PART 2 - PRODUCTS

2.01 GENERAL

Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
Water or other liquid	AWWA C151
Gas	ANSI A21.52
Gravity service pipe	ASTM A716
Joints	
Rubber gasket	AWWA C111
Threaded flange	AWWA C115
Fittings	
Water or other liquid	AWWA C110/AWWA C153
Gas	ANSI A21.14
Cement mortar lining	AWWA C104

2.02 PIPE

Ductile iron pipe shall be in accordance with ANSI A21.50/AWWA C150 and conform to the requirements of A21.51/AWWA C151, latest standards. Push-on, and restrained joint pipe shall have a minimum rated working pressure of 150 psi. All buried pipe shall have the minimum pressure class listed below:

Pipe Sizes (inches)	Pressure Class (psi)
4-12	350
14-20	250
24	200
30-64	150

2.03 GASKETS

Unless otherwise specified, gaskets shall be standard styrene butadiene copolymer (SBR) with a max service temperature in water/sewer and air of 150 degrees F. and shall be suitable for freshwater, saltwater and sanitary sewer application. Mechanical joint rubber gasket configuration and materials shall comply with AWWA C111 and shall be in accordance with the applicable joint type and pressure rating of the piping system. Gaskets shall, in addition, comply with AWWA C111 for push-on and mechanical joints and with AWWA C606 for grooved end joints. If organic solvents or petroleum products are encountered during the course of the work, alternate gasket materials or joint treatment may be required by the Engineer.

2.04 FITTINGS

Unless otherwise specified, fittings shall conform to AWWA C110. Ends shall be flanged, restrained mechanical joint, restrained push-on, or grooved to suit the conditions specified. The AWWA C153 compact ductile iron fittings in sizes 3 through 12 inches are an acceptable substitute for standard fittings unless otherwise specified. Long-radius elbows shall be provided where specified. Grooved end fittings shall comply with paragraph 40 27 05-1.02 B.

2.05 JOINTS

A. UNRESTRAINED JOINTS:

1. PUSH-ON JOINTS: Unrestrained joints, where specified, shall be the rubber ring compression, push-on type joint suitable for buried service. Unrestrained joints shall be the Fastite Joint as manufactured by American Cast Iron Pipe Company, the Tyton Joint as manufactured by U.S. Pipe, or equal. This joint is not permitted on fittings or specials, unless otherwise specified. Unless otherwise specified, joints shall have an allowable deflection up to 5 degrees at specified pressures. Joint assembly and field cut joints shall be made in strict conformance with AWWA C600 and manufacturer's recommendations.

2. MECHANICAL JOINTS: Where specified, mechanical joints for above or below ground service shall meet the requirements of ANSI/AWWA

A21.10/C110 and ANSI/AWWA A21.11/C111. Gaskets and bolts and nuts shall comply with paragraphs 33 05 01.03-2.03 and 2.05 D, respectively.

B. RESTRAINED JOINTS:

1. GENERAL: Unless otherwise specified, restrained joints are required for all exposed and buried piping. Unless otherwise specified, restrained joints shall be flanged or grooved end for exposed service and restrained push-on for buried service.

2. PUSH-ON JOINTS: Restrained push-on joints shall be as specified in paragraph 33 05 01.03-2.05 A.1., modified for restraint. Joints shall be the Flex-Ring or Lok-Ring Joint as manufactured by American Cast Iron Pipe Company, TR Flex Joint as manufactured by US Pipe, or equal. Restrained joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the Construction Manager.

3. FLANGE ASSEMBLIES: Unless otherwise specified, flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA A21.15/C115 or cast-on flanges conforming to ANSI/AWWA A21.10/C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.

   Unless otherwise specified, bolts and nuts for flange assemblies shall conform with paragraph 40 27 05.04-2.01 C. Gaskets shall be as specified in paragraph 40 27 05.04-2.01 B.

4. MECHANICAL JOINTS: Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.

   Locked mechanical hydrant tees, bends and adapters are an acceptable substitute for anchoring fire hydrants and valves to the pipe main.

5. Restrained Joints: Shall be EBBA Megalug or approved equal.

C. BALL AND SOCKET FLEXIBLE JOINT PIPE:

Ball and socket flexible joint pipe shall be the boltless type and shall allow a maximum joint deflection of 15 degrees. Each joint shall be provided with a retainer lock to prevent rotation after assembly. Joints shall be the Flex-Lok Joint as manufactured by American Cast Iron Pipe Company, USIflex as manufactured by U.S. Pipe, or equal.

D. BOLTS AND NUTS:

Stainless steel (SS316) bolts and nuts for use with ductile iron joints shall used. Bolts and nuts shall be lubricated with an Owner-approved anti-seize compound.

2.06 PIPE COATING

Unless otherwise specified, pipe and fittings shall be coated with asphaltic material (min. 1mil) as specified in AWWA C151.

2.07 PIPE LINING

A. WATER AND REUSE WATER LININGS

Cement mortar lining is advisable for lines handling pH levels ranging from 6-10. Other pH levels shall have suitable lining. Ductile iron pipe, specials, and fittings shall be lined with cement mortar lining in accordance with AWWA C104.

B. SEWAGE SERVICE LININGS

Ductile iron pipe and fittings shall receive an interior lining of 40-mil (min.) nominal Protecto 401 epoxy, or equal.

C. SCUM & GRIT LINING

Glass lined.

2.08 PRODUCT DATA

The following information shall be provide:

1. Shop drawings.

2. Alignment drawings.

3. Certifications specified in the following documents:

ANSI A21.14, paragraph 14-4.2
ANSI A21.52, paragraph 52-4.2
ASTM A716, paragraph 4.2
AWWA C110, paragraph 10-5.3
AWWA C111, paragraph 11-7.1
AWWA C115, paragraph 15-4.2
AWWA C151, paragraph 51-5.2
AWWA C153, paragraph 53-6.3
AWWA C606, paragraph 4.1.1.1

2.09 QUALITY ASSURANCE

Contractor shall submit evidence that the ductile iron pipe and fitting manufacturer has a minimum of ten years' experience in material production of diameters noted on the plans and specifications. Ductile iron pipe is preferred to be domestically manufactured in the United States. All pipe material suppliers shall be ISO registered or provide the services of an independent inspection agency. Prior to the start of manufacturing, any manufacturer not meeting the ISO registration requirements shall submit to the Owner and Owner's Engineer the names of an independent inspection agency for approval.

2.10 PRODUCT DELIVERY, STORAGE & HANDLING

Material shall be unloaded in a manner that will avoid damage and shall be stored where it will be protected and will not be hazardous to traffic. It shall be handled according to manufacturer's recommendations. A fork inserted inside the pipe is not allowed. The Contractor shall repair or replace any damage caused by the storage or handling. Material shall be examined before installation and neither damaged nor deteriorated material shall be used in the work. Owner and Engineer have the right to reject defective or damaged material.

Delivery, storage, and handling of ductile-iron pipe and fittings shall follow the recommendations of AWWA C600 and as specified herein:

a. Handling of pipe shall be performed with lifts, cranes, or other suitable equipment and devices. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the pipe, linings, and coatings. The pipes shall not be dropped or dragged.
b. During transport, the pipe shall be supported and secured against movement using padded devices in such a manner to prevent damage.
c. Stored pipe shall be protected from damage and kept free from dirt and foreign materials by closing the ends of the pipe. Other pipeline materials shall be protected by appropriate packaging or wrapping. Gaskets shall be stored in a cool location out of direct sunlight. Bolts, nuts, and washers shall be handled and stored in a dry location in a manner that will ensure proper use with respect to types and sizes.
d. Pipe laid out for installation shall be placed on earth berms or timber cradles adjacent to the trench in the numerical order of installation.
e. Maintain plastic end caps on all pipe and fittings in good condition until the pipe is ready to be installed in the trench. Periodically open the plastic end caps and spray clean potable water inside the pipe for moisture control.
f. Under no circumstances shall ropes or other handling devices be attached through the interior of fittings

2.11 RECYCLED/EFFLUENT WATER IDENTIFICATION

Ductile-iron pipe and fittings for recycled or effluent water shall be identified with purple-colored coating, sleeves, identification labels or signs.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL:

Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted.

Pipe shall be installed in accordance with AWWA C600.

Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes, including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

B. INSULATING SECTIONS:

Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in paragraph 40 27 05.04-3.05.

C. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted.

3.02 ACCEPTANCE TESTING

Hydrostatic pressure tests shall be conducted in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 27 05.

The Contractor shall conduct the tests in the presence of the Engineer or Owner.

END OF SECTION

INDEX TO

SECTION 33 05 01.09

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

SECTION 33 05 01.09

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

PART 1 – GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):

   a. C110, Ductile-Iron and Gray-Iron Fittings for Water.
   b. C116, Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey iron Fittings for Water Supply Service.
   c. C153, Ductile-Iron Compact Fittings, for Water Service.
   d. C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
   e. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches through 12 Inches (100 mm through 300 mm), for Water Distribution.
   f. C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 Inches (350 mm through 1,200 mm) for Water Transmission and Distribution.
   g. C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 Inches through 12 Inches (100 mm through 300 mm), for Water Distribution.

2. ASTM International (ASTM):

   a. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   b. D2241, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
   c. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   d. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
   e. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
   f. D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

3. NSF International (NSF).

1.02 SUBMITTALS

A. Action Submittals: Drawings showing pipe diameter, pipe class, and fitting details.

B. Informational Submittals:
1. Manufacturer's Certificate of Compliance, in accordance with Section 01 0001, General Requirements.
2. Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

    a. Testing dates.
    b. Piping systems and section(s) to be tested.
    c. Method of isolation.
    d. Method of conveying water from source to system being tested.
    e. Calculation of maximum allowable leakage for piping section(s) to be tested.

3. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
4. Test report documentation.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Solvent Cement: Store in accordance with ASTM D2855.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Pipe:

1. PVC, conforming to requirements of AWWA C900 for diameters 12 inches and smaller or AWWA C905 for diameters larger than 12 inches.
2. DR shall be 18 for C900 pipe and 25 for C905 pipe.
3. Pipe to be used for potable water conveyance shall be manufactured from National Sanitation Foundation (NSF) approved compounds.

B. Joints:

1. Rubber gasketed.
2. Conform to AWWA C900 or AWWA C905.

C. Fittings: Conforming to AWWA C153 or AWWA C110. Fusion bonded epoxy coating (interior and exterior) ductile iron or cement-lined ductile iron as specified on the Pipe Schedule included as a supplement to Section 40 27 00, Process Piping-General.

D. Service Saddles:

1. Double strap type with minimum strap width of 2 inches.
2. Straps shall be Type 304 stainless steel. Saddles shall be Romac 202NS nylon coated saddles or approved equal.
3. Minimum Pressure Rating: 150 psi.

E. Restrained Joints:

Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to “Megalug” or push-on type joints equivalent to "Lok-Ring," "TR Flex," or "Super Lock" and shall have a minimum rated working pressure of 250 psi for ductile iron pipe and 100 psi with a minimum safety factor of 2:1 for PVC pipe. The joints shall be in accordance with the applicable portions of AWWA C-111. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested without signs of leakage or failure. Restrained joints shall be capable of being deflected after assembly.

PART 3 – EXECUTION

3.01 INSTALLATION

A. In accordance with A WW A C605.

B. Solvent cement used for joints as recommended by pipe manufacturer.

C. Joints:

1. Rubber Gasketed: In accordance with manufacturer's written instructions.
2. Solvent Cemented: In accordance with ASTM D2855.
3. Restrained Joint Systems: In accordance with manufacturer's written instructions.

D. Pipe Bending for Horizontal or Vertical Curves:

1. Radius of curves shall not exceed 75 percent of manufacturer’s recommended values.
2. Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

E. Maximum Joint Deflection: 75 percent of manufacturer’s recommended values.

3.02 INSPECTION AND HYDROSTATIC TESTING

A. General: In accordance with Section 40 80 01, Process Piping Leakage Testing.

END OF SECTION

INDEX TO

SECTION 33 05 01.12

GRAVITY SEWER PIPE AND FITTINGS

SECTION 33 05 01.12

GRAVITY SEWER PIPE AND FITTINGS

PART 1 – GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):

   a. C105, Polyethylene Encasement for Ductile Iron Pipe Systems.
   b. C110, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm through 1200 mm), for Water.
   c. C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe -4 in. (100 mm) and Larger -Shop Applied.
   e. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
   f. C302, Reinforced Concrete Pressure Pipe, Noncylinder Type.
   g. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in. (100 mm through 300 mm), for Water Distribution.

2. ASTM International (ASTM):

   a. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   b. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C150, Standard Specification for Portland Cement.
   e. C151, Ductile-Iron Pipe, Centrifugally Cast, for Water.
   f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   g. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
   h. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   i. C596, Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
   j. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   k. D16, Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   l. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
   m. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

n. D2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
o. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
p. D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
q. D3212, Standard Specification for Joints For Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
r. E329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
s. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
t. F679, Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

1.02 DEFINITIONS

A. SDR: Standard Dimension Ratio.

1.03 SUBMITTALS

A. Action Submittals: Information on gasket polymer properties.

B. Informational Submittals:

1. Certificates:

a. Manufacturer's Certificate of Compliance, in accordance with Section 01 0001, General Requirements, that products furnished meet requirements of this section.
b. Certified statement from manufacturer of gaskets, setting forth that basic polymer used in gaskets and test results of physical properties of compound are in accordance with ASTM F477 for PVC pipe.

2. Manufacturer's Written In-Plant Quality Control Program: Quality control procedures and materials testing to be used throughout manufacturing process. Submit prior to manufacture of any pipe for this Project.
3. Test or historical performance data to verify that joint design meets requirements of these specifications.
4. Provide pipe test results with delivery of pipe. Do not deliver pipe not meeting test requirements to Project Site.
5. Manufacturer's written recommendations for pipe handling and installation.
6. PVC pipe deflection test results.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC)

A. 15-Inch Diameter and Smaller:

1. In accordance with ASTM D3034.
2. Joints: Integral bell and spigot, in accordance with ASTM D3212.
3. Minimum SDR: 26.
4. Cell Classification: 12454-B or 12454-C, as defined by ASTM D1784.
5. Fittings: SDR 35 minimum wall thickness.
6. Gaskets: Factory fabricated rubber compression type with solid cross section in accordance with ASTM F477. Lubricant for joining pipe as approved by pipe manufacturer.

2.02 FLEXIBLE COMPRESSION COLLAR

A. Mechanical joint coupling with No. 305 stainless steel bands.

B. Manufacturers:

1. Calder, Inc., Bellflower, CA.
2. Femco Inc., Davison, MI.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Notify Engineer immediately of manufacturing imperfections or damage caused by improper handling.

B. Verify size, pipe condition, and pipe class prior to installation of pipe.

3.02 PREPARATION

A. Pipe Distribution: Do not distribute more than 1 week's supply of materials in advance of laying, unless otherwise approved by Engineer.

B. Inspect pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are being used.

C. Remove foreign matter and dirt from inside of pipe and fittings and keep clean during and after laying. Wash ends of section clean with wet brush prior to joining sections of pipe.

3.03 INSTALLATION

A. General:

1. Install pipe sections in accordance with manufacturer's recommendations.
2. Provide and use proper implements, tools, and facilities for safe and proper prosecution of Work.
3. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings. Do not drop or dump pipe into trenches.

B. Line and Grade:

1. Establish line and grade for pipe by use of lasers.
2. Measure for grade at pipe invert, not at top of pipe.
3. Do not deviate from line or grade, as shown on Drawings, more than *1/2* inch, provided that such variation does not result in a level or reverse sloping invert.

C. Laying and Jointing:

1. Use gasket lubricant as recommended by gasket manufacturer.
2. Lay pipe upgrade with bell ends pointing in direction of laying.
3. When field cutting or machining pipe is necessary, use only tools and methods recommended by pipe manufacturer and approved by Engineer.
4. After section of pipe has been placed in its approximate position for jointing, clean end of pipe to be joined, inside of joint, and rubber ring immediately before joining pipe.
5. Assemble joint in accordance with recommendations of manufacturer.
6. Apply sufficient pressure in making joint to assure that joint is "home" as defined in standard installation instructions provided by pipe manufacturer. Inside joint space shall not exceed 50 percent of pipe manufacturer's recommended maximum allowance.
7. Place pipe to specified line and grade to form smooth flow line.
8. Ensure that bottom of pipe is in contact with bottom of trench for full length of each section.
9. Check for alignment and grade after joint has been made.
10. Place sufficient pipe bedding material to secure pipe from movement before next joint is installed.
11. When pipe is laid within movable trench shield, take precautions to prevent pipe joints from pulling apart when moving shield ahead.

    a. When laying operations are not in progress, and at close of day's work close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints.
    b. Take precautions to prevent "uplift" or floating of line prior to completion of backfill operation.

c. Connections between one pipe material and another shall be by means of flexible compression collar, installed in accordance with the manufacture's recommendations, or concrete closure collar.

D. Connection to Structure or Manhole:

1. Locate standard pipe joint within 1.5 feet of outside face of structure for pipe 18 inches and smaller and within one pipe diameter for pipe 21 inches and larger.
2. Plug or close off pipe stubbed with watertight plug.
3. Connect PVC pipe to manhole with pipe to manhole connector in accordance with manufacturer's recommendations.

3.04 CLEANING

A. Clean each section of completed sewer pipeline prior to testing.

B. Place screen or dam in downstream manhole of section being cleaned to catch debris.

C. Remove material from each manhole section before cleaning the next section downstream.

D. Method: High velocity hydro-cleaning equipment.

E. Cleaning water may not be discharged into existing sewer system after screening and removal of debris.

3.05 GASKET FIELD SPLICE TESTS

A. Perform field splice test on 20 percent of each lot of delivered gaskets, in accordance with ASTM C361 in presence of Engineer.

B. Furnish feeler gauges of proper size, type, and shape to verify proper placement of gasket.

C. Test section of gasket shall be at point where ends of gasket are joined together.

D. If gasket joints separate during test, entire lot will be rejected and shall immediately be removed from Site.

3.06 HYDROSTATIC AND PNEUMATIC TESTS

A. General: In accordance with 408001, Process Piping Leakage Testing.

END OF SECTION

INDEX TO

SECTION 33 32 20

WASTEWATER PUMP STATIONS

SECTION 33 32 20

WASTEWATER PUMP STATIONS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Sewer Pipes.

B. Pumping Station Upgrade.

1.02 RELATED SECTIONS

A. Section 33 32 21 – Flow Diversion (Bypass Pumping).

B. Section 01 75 15 – Pump Station – Start up.

1.03 OPTIONS

A. The specifications describe several materials. The Owner will decide which ones to be used. Where manufacturers and models of equipment are named in the specifications, it is intended these are to describe quality and function required. Contractor may use equipment or materials of other manufacturers provided they are reviewed and accepted by the Engineer, Owner, and Regulatory Agency and Operator as equivalent to those specified.

1.04 REFERENCES (Latest Revision)

A. ASTM D 3034 – Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

B. ANSI/AWWA C 150/A 21.50 – Thickness Design of Ductile Iron Pipe.

C. ANSI/AWWA C 151/A 21.51 – Ductile Iron Pipe, Centrifugally Cast, for Water, or Other Liquids.

D. ASTM A 746 – Ductile Iron Gravity Sewer Pipe.

E. ASTM D 3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

F. ASTM F 477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

G. ASTM D 2241 – Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

H. ASTM D 3139 – Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

I. ASTM C 443 – Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

J. ACI 318 – Building Code Requirements for Structural Concrete.

K. ASTM C 39/C 39M – Compressive Strength of Cylindrical Concrete Specimens.

L. ASTM C 890 – Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

M. ASTM C 891 – Installation of Underground Precast Concrete Utility Structures.

N. ASTM C 913 – Precast Concrete Water and Wastewater Structures.

O. ASTM A 615/A 615 M – Deformed and Plain Carbon – Steel Bars for Concrete Reinforcement.

P. ASTM D-6938 – In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

Q. ASTM D 2794 – Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

R. ASTM E 96 – Water Vapor Transmission of Materials.

S. ASTM G 154 – Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

T. ANSI/AWWA C 111/A 21.11 – Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

U. ASTM A 377 – Index of Specifications for Ductile Iron Pressure Pipe.

V. ANSI/AWWA C 600 – Installation of Ductile Iron Water Mains and Their Appurtenances.

W. ANSI/AWWA C115/A21.15 – Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.

X. ANSI/AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches through 12 inches, for Water Transmission and Distribution.

Y. ANSI/AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 inches, for Water Transmission and Distribution.

1.05 QUALITY ASSURANCE

A. Contractor will furnish the Engineer and Owner a description of all material before ordering. Engineer will review the Contractor's submittals and provide in writing an acceptance or rejection of material.

B. Where ductile iron pipe is indicated on the plans, or required by Engineer, it shall be used.

C. Material and equipment shall be the standard products of a manufacturer who has manufactured them for a minimum of two years and provides published data on their quality and performance.

D. A subcontractor for any part of the work must have experience on similar work, and if required, furnish Engineer with a list of projects and Owners or Engineers who are familiar with its competence.

E. If Contractor wishes to furnish devices, equipment, structures, and systems not designed by Engineer, these items shall be designed by either a Professional Engineer registered in the project state or by someone Engineer accepts as qualified. If required, complete design calculations and assumptions shall be furnished to the Engineer or Owner before acceptance.

F. Testing shall be by a testing laboratory which operates in accordance to ASTM D 3740 or E 329 and shall be acceptable to Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regularly scheduled tests, spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making test.

G. Pump performance, and hydrostatic tests on force mains shall be made by Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

H. Perform work in accordance with the State of South Carolina, South Carolina Department of Health and Environmental Control minimum standards.

I. Install pumps and their associated mechanical, electrical and control accessories according to manufactures instructions.

J. Infiltration, line, and grade of sewer, pump performance, and hydrostatic tests on force mains shall be made by Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Material shall be unloaded in a manner avoiding damage and shall be stored where it will be protected and will not be hazardous to traffic. If stored on private property, Contractor shall obtain permission from property owner and shall repair any damage caused by the storage. Material shall be examined before installation. Neither damaged nor deteriorated material shall be used in the work.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping system from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of complete system.

D. Accept system components on site in manufacturer's original containers or configuration. Inspect for damage.

E. Store sensitive materials for field assembly in dry area in original shipping containers.

F. Repair damage to wet well and other infrastructure according to manufacturer's instructions.

1.07 JOB CONDITIONS

A. Installation of the improvements must be coordinated with ongoing operations.

B. Contractor shall replace or repair any damaged pipe or structure at no additional expense to the Owner.

C. Installation of the sanitary sewerage system must be coordinated with other work on site. Generally, sanitary sewer pipes will be installed first and shall be backfilled and protected so subsequent excavating and backfilling of other utilities does not disturb them. Contractor shall replace or repair any damaged pipe or structure at no additional expense to the Owner.

1.08 ALTERNATIVES

A. The intention of these specifications is to produce the best system for the Owner. If the Contractor suggests alternate material, equipment or procedures will improve results at no additional cost, Engineer and Owner will examine suggestion, and if accepted, it may be used. The basis upon which acceptance of an alternate will be given is its value to the Owner, and not for Contractor's convenience.

1.09 GUARANTEE

A. Contractor shall guarantee quality of materials, equipment, and workmanship for 12 months after acceptance of the completed Project. Defects discovered during this period shall be repaired by Contractor at no cost to the Owner.

1.10 EXISTING UTILITIES

A. All known utility facilities are shown schematically on the construction drawings, and are not necessarily accurate in location as to plan or elevation. Utilities such as service lines or unknown facilities not shown will not relieve the Contractor of responsibility under this requirement. "Existing Utilities Facilities" means any utility existing on the project in its original, relocated, or newly installed position. Contractor will be held responsible for cost of repairs to damaged underground facilities, even when such facilities are not shown on the drawings.

B. The Contractor shall call for underground utility locations before starting work. Underground utilities location service can be contacted at 1-888-721-7877 (SC) or 811.

1.11 TESTING

A. Laboratory tests for moisture density relationship for fill materials shall be in accordance with ASTM D 1557, (Modified Proctor).

B. In place density tests in accordance with ASTM D 2922.

C. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

D. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48 hours' notice prior to taking any tests.

E. Testing shall be Contractor's responsibility and shall be performed at the Contractor's expense by a commercial testing laboratory operating in accordance with subparagraph C above.

F. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

1.12 PRE-INSTALLATION MEETINGS

A. Section 01 31 00 – Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.13 PERFORMANCE REQUIREMENTS

A. Operation:

1. Provide 2 floats and one Ultrasonic Level transmitter approved by Owner/Operator. Set elevations in accordance with Drawings or as directed by Engineer. Set pumps to automatically switch operations from one pump to another after shut off of each pumping cycle.

B. Sound, Vibration, and Thermal Control – Dampen or suppress noise, absorb vibration, accommodate thermal expansion and stresses, and adjust or correct for misalignment in piping systems.

PART 2 – PRODUCTS

Materials and products used shall conform to one of the following and shall be as approved by the Engineer:

2.01 SEWER PIPE

A. PVC Pipe – Shall be polyvinyl chloride plastic (PVC) and shall meet all requirements of ASTM D 3034 SDR 26, except for depths less than three feet where ductile iron pipe must be installed. All pipe shall be suitable for use as a gravity sewer conduit. Provisions must be made for contraction and expansion at each joint with a rubber gasket. Pipe sizes and dimensions shall be as shown below. All

pipe shall be green or white in color with factory marked homing lines. Fittings shall meet the same specification requirements as pipe.

Nom. Size	Outside Diameter		Min. Wall Thickness
	Average	Tolerance	SDR-26
4	4.215	± 0.009	.162
6	6.275	± 0.011	.241
8	8.400	± 0.012	.323
10	10.500	± 0.015	.404
12	12.500	± 0.018	.481

Tests on PVC Pipe – Pipe shall be designed to pass all tests at 73 °F. (± 3 °F.).

B. Ductile Iron – Shall conform to ANSI A 21.50 (AWWA C 150), ANSI A 21.51 (AWWA C 151) and ASTM A 746. All pipe shall be Pressure Class 350 unless otherwise noted. All ductile iron pipes and fittings shall be bituminous coated on the outside and lined with Protecto 401 Ceramic Epoxy or equivalent on inside.

1. Coating on the outside shall be an asphaltic coating approximately 1 mil thick. Finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to sun, and shall be strongly adherent to the iron.

2. Protecto 401 Ceramic Epoxy or equivalent interior lining shall conform to ASTM E 96, ASTM D 714, ASTM D 2794 and ASTM G 53. Interior of the pipe shall receive 40 mils nominal dry film thickness of epoxy. Lining application, inspection, certification, handling, and surface preparation of area to receive the protective coating shall be in accordance with manufacturer's specifications and requirements.

2.02 JOINTS - GRAVITY SYSTEM

A. Joints for Ductile Iron Pipe – Shall be slip-on rubber equivalent to "Fastite," "All-tite," or "Tyton."

B. Joints for PVC Pipe – Shall be integral wall bell and spigot with a rubber ring gasket. Joints shall conform to ASTM D 3212 and gaskets to ASTM F 477.

2.03 FORCE MAIN

A. P.V.C. – All pipe shall be green in color with factory marked homing lines. Pipe with diameter less than 4 inches shall conform to all requirements of ASTM D 2241, SDR 26, Class 160. Pipe 4 inches through 12 inches shall conform to all requirements of AWWA C900, DR 25, Pressure Class of 165 p.s.i. Pipe 14 inches through 18-inches shall conform to all requirements of AWWA C905 with C1 outside diameter, DR 25, with a pressure rating of 165 p.s.i. Joints shall be in accordance with ASTM D 3139.

B. Ductile Iron pipe shall be in accordance with Paragraph 2.1-B and conform to ASTM A 377. Push-on-Joints shall be slip-on rubber equivalent to "Fastite," "All-tite,"

or "Tyton." Flanged joints shall conform to AWWA C 115. Gaskets shall conform to AWWA C 111.

C. Thrust blocking shall be sized as detailed on the construction drawings of 3,000 p.s.i. concrete. Blocking shall be provided at all bends deflecting 11-1/4° or more and bear directly against the undisturbed trench wall.

D. Restrained Joints – Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Megalug" or push-on type joints equivalent to "Lok-Ring," "TR Flex," or "Super Lock" and shall have a minimum rated working pressure equal to the item restrained with a minimum safety factor of 2:1. Joints shall be in accordance with the applicable portions of AWWA C-111. Manufacturer of joints shall furnish certification, witnessed by an independent laboratory, stating joints furnished have been tested without signs of leakage or failure. Restrained joints shall be capable of being deflected after assembly.

2.04 STONE BACKFILL

A. Shall be graded crushed granite with the following gradation:

Square Opening Size	Percent Passing
1 inch	100%
3/4 inch	90 to 100%
3/8 inch	0 to 65%
No. 4	0 to 25%

2.05 SAND BACKFILL

A. Shall be clean sand free from clay and organic material. Not more than 10% shall pass the No. 100 sieve.

2.06 BORROW

A. Where it is determined sufficient suitable material is not available from the site to satisfactorily backfill pipe to at least two feet above top of pipe, Contractor, at no additional cost, shall furnish suitable sandy borrow material to accomplish requirements. Material shall not have more than 60% passing the No. 100 sieve, nor more than 20% passing a No. 200 sieve.

2.07 AIR RELEASE VALVE

A. Shall be designed for sewage service. The valve shall be constructed of a cast iron body, stainless steel or bronze trim, and stainless steel float. The inlet shall be two inches. The working pressure shall be 0 to 50 p.s.i. It shall be on automatic air valve.

2.08 METAL DETECTOR TAPE

A. Will be installed above all pipe. Tape shall consist of 0.35 mils thick solid foil core encased in a protective plastic jacket resistant to alkalis, acids, and other destructive elements found in the soil. The lamination bond shall be strong enough so layers cannot be separated by hand. Total composite thickness shall be 5.0 mils. Foil core to be visible from unprinted side to ensure continuity. The tape shall have a minimum three-inch width and a tensile strength of 35 pounds per inch.

A continuous warning message indicating "sewer line" repeated every 16 inches to 36 inches shall be imprinted on the tape surface. Tape shall contain an opaque color concentrate designating color code appropriate to the line being buried (Sewer Line - Green).

2.09 MANHOLES

A. Masonry – Shall be new whole brick of good quality laid in masonry mortar or cement mortar made of one part Portland cement and two parts clean sharp sand. Every brick shall be fully bedded in mortar. Manholes shall conform to locations and details shown on the plans.

B. Precast Concrete – Shall be reinforced concrete constructed in accordance with ASTM C 478 and details shown on the plans "Precast Concrete Manholes." Coarse aggregate shall be granite stone. The joints shall be tongue and groove sealed with flexible gaskets or mastic sealant. Gaskets shall be O–Ring or equivalent to Type A or B "Tylox" conforming to ASTM C 443. Mastic shall be equivalent to "Ram–nek" with primer. Primer shall be applied to all contact surfaces of manhole joint at the factory in accordance with manufacturer's instructions.

C. Frames and Covers – Shall be cast iron equivalent to the following:

[Neenah Foundry Co. R–1668 Type "C" Lid]

D. Manhole Steps – Shall be equivalent to M.A. Industries, Type PS–1 or PS–2–PF. Steps shall be installed at the manhole factory and in accordance with recommendations of step manufacturer. Manholes will <u>not</u> be acceptable if steps are not installed accordingly.

E. Pipe Connections – Shall have flexible watertight joints at sewer main point of entry into the manhole. The joint shall be an EPDM or polyisoprene sleeve equivalent to "Kor–N–Seal."

F. Coatings – New manholes shall have all interior surfaces coated with a factory applied acrylic polymer–base coating and sealant. The coating shall be ConSeal CS–55 manufactured by Concrete Sealants, New Carlisle, Ohio or an accepted equivalent. The coating shall be applied in three coats to achieve a total dry film thickness of at least 3.5 mils in accordance with manufacturer's recommendations. Surfaces shall be cleaned of all dust, form oils, curing compounds and other foreign matter prior to the coating application.

All new or existing manholes shall be coated with 125 wet film mils of Raven 405 ultra-high build epoxy or an accepted equivalent. The interior surfaces shall be cleaned and prepared according to manufacturer's recommendations.

2.10 PLANT DRAIN PUMP STATION

A. Shall be dual submersible pumps installed in a concrete wet well. Pumps shall be equivalent to Flygt or ABS conforming to characteristics shown on the drawings.

Pump Station

Flygt	CP 310L with 183 IMP
TDH	30
Pump Capacity	250
Maximum RPM	1,740
Phase	3
Voltage	230
Minimum HP	5
Minimum Efficiency	72

B. Wet Well Sections – Shall be precast reinforced concrete sections. The product design, performance, materials, manufacturing, handling, and installation shall conform to following references and project specifications:

ACI 318 – Building Code Requirements for Reinforced Concrete

ASTM C 39 – Compressive Strength of Cylindrical Concrete Specimens

ASTM C-478 – Precast Reinforced Concrete Manhole Sections

ASTM C 890 – Minimal Structural Design Loading for Precast Concrete Water and Wastewater Structures

ASTM C 891 – Installation of Underground Precast Concrete Utility Structures

ASTM C 913 – Precast Concrete Water and Wastewater Structures

1. Contractor or supplier shall provide for design of the precast structure. Each section of the structure shall be designed and manufactured for its individual depth, loading conditions (lateral, surcharge and hydrostatic), and opening requirements. All concrete in the precast structure shall have a minimum compressive strength of 4,500 p.s.i. after 28 days. Reinforcing steel shall comply with ASTM A 615 Grade 60 (min. fy = 60,000 p.s.i.). Bar bending and placement shall comply with the ACI latest standards.

2. Precast structure manufacturer shall have necessary equipment and facilities for proper manufacture of the sections and to perform compressive strength tests on concrete tests specimens. Test cylinders shall be made for each structure and test conducted in accordance with ASTM C 39, except compressive strength shall be equal to or greater than design of the concrete. Structure design computations, concrete mix

design, and test reports certifying design strength has been achieved at the 28 day break shall be submitted to Engineer. Design of structure shall be performed by a Professional Engineer registered in the state of installation at Contractor's expense. The design parameters for a precast structure shall include:

a. Lateral load based on a water table at the surface using equivalent fluid pressure of 80 p.c.f. from surface grade down and a vehicle wheel load designation of HS20-44. Design live load for the top slab shall be 300 p.s.f. The precast concrete sections shall have a minimum wall thickness of six inches and minimum top and bottom slab thicknesses of eight inches. Actual thicknesses greater than minimum shall be as required by the loading conditions.

b. Access hatches in the top slab of wet-well structure shall be for clear opening dimensions indicated and have a load capacity of 300 p.s.f. The material shall be Aluminum Alloy 6063-T5 and T6, minimum 1/4 inch thick plate, flush-type lock with inside spoon handle. The frame shall be complete with hinged and hasp-equipped cover, upper guide holders, chain holders and cable holder. Chain and cable holders shall be stainless steel or aluminum. Frame shall be securely mounted above the pumps. The hatch covers shall be torsion-bar loaded for ease of lifting and shall have a safety-locking handle in open position. Access hatch shall be provided with a safety grate.

3. Contractor shall furnish and install guide bars for each pump to permit raising and lowering the pump. Guide bars shall be stainless steel and of adequate length and strength to extend from lower guide holders on the pump discharge connection to upper guide holder mounted on access frame.

4. The wet well shall be provided with sleeves, 24 inches below finished grade, for access of power and control conduits. The sleeves shall be of proper size and number to accommodate all necessary power and control conduits.

5. All interior concrete surfaces shall have either a minimum 125 mils coating of Raven 405, or an accepted equivalent.

6. The structure manufacturer shall prepare and submit six sets of shop drawings showing wall and slab thicknesses, structural reinforcing and opening locations. The manufacturer shall also provide design analyses and calculations to show all sections have been designed for burial depths shown on construction drawings as well as stresses incurred during transport, handling and installation. Calculations and analyses must be performed and sealed by a Licensed Professional Engineer from the state project is located and submitted for review. All shop drawings and design calculations shall be submitted to the Contractor for review. Contractor shall forward these documents to the Engineer. Such documents shall bear the stamp or written statement of Contractor indicating Contractor's

review for completeness and receipt. Contractor shall be responsible for the accuracy of shop drawings and for their conformity to plans and specifications. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by Contract Documents.

C. Pump Design – Pumps shall be capable of handling raw, unscreened sewage with the capacity to pass three-inch diameter spheres. Pumping units shall be automatically connected to discharge piping when lowered into place on the discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts, or other fastening to be removed for this purpose, and no need for personnel to enter wet well. Each pump shall be fitted with a stainless steel chain of adequate strength and length to permit raising the pump for inspection and removal.

D. Pump Construction – The pump(s) shall be designed to pump sewage, storm water, heavy sludge, and other fibrous materials without injurious damage during operation. The lifting cover, stator housing and volute casing shall be of gray iron construction with all nuts, bolts, washers and other fastening devices coming into contact with sewage, constructed of stainless steel and protected by primer coat and a coat of rubber-asphalt or epoxy paint. The impeller shall be hard alloy gray iron construction, dynamically balanced, double shrouded, non-clogging design with a long thoroughfare and no acute angles.

1. The pump motor shall be of Class F Insulation, NEMA B design, watertight and positively oil cooled, filled with a transformer oil, equivalent to BP JS-HA, Shell Diala D, or housed in an air-filled watertight chamber. The pump motor shall be guaranteed to run in a totally, partially or non-submerged condition continuously for a period of 24 hours without injurious damages. Water cooled pumps shall not be considered equal. Before final acceptance, a field running test at job site demonstrating the ability to operate continuously for 24 hours under a non-submerged condition, shall be performed for all pumps being supplied, if required. The pump shall be provided with a tandem double mechanical seal running in an oil bath. The seals shall be of lapped tungsten carbide and welded to stainless steel retainers and held in contact by separate springs. Conventional double mechanical seals with a spring assembly between the rotating faces, requiring constant differential pressure to effect sealing and subject to penetration and opening by pumping forces shall not be considered equal to tandem seal specified and required. The pump shaft shall be of stainless steel and supported by a double row inboard bearing for axial thrust and a single row outboard bearing for radial thrust. The impeller shall be connected to a short sturdy shaft in order to minimize shaft deflection. Shaft shall not extend more than 2-1/2 times its diameter below the nearest support bearing.

2. The pump cable shall be of proper length to reach from pumps in wet well to control panel without any splices. Cable shall be the "SO" or hypalon jacketed SPC type and in compliance with industry standards for loads, resistance against sewage and of stranded construction. Cable shall

enter the pump through a heavy duty entry assembly, which shall be provided with an internal grommet assembly to protect against leakage once secured and must have a strain relief assembly as part of standard construction. Power cable shall connect to a terminal board separating incoming service from pump motor, where if leakage occurs, terminal board will short out and not cause damage to the motor.

3. Each pump shall be supplied with a universal coupling which bolts to pump discharge flange and shall accept the discharge elbow provided by pump manufacturer. Seal of the pump at discharge flange shall be accomplished by a single downward linear motion of pump with entire weight of pump guided to and pressing against discharge connection. No part of pump shall bear directly on the sump floor and no rotary motion of pump shall be required for sealing. Sealing at the discharge shall be designed to insure a positive leakproof system and for ease of removal. Pump shall be guaranteed not to leak at the discharge flange.

E. Pump Test – Pump manufacturer shall perform following tests on each pump before shipment from the factory:

1. Megger the pump for insulation breaks or moisture.

2. Prior to submergence, the pump shall be run dry and checked for correct rotation.

3. Pump shall be run for 30 minutes in a submerged condition.

4. Pump shall be removed from test tank, meggered immediately for moisture; oil plugs removed for checking of upper seal and possible water intrusion of stator housing.

5. A written certified test report giving above information shall be supplied with each pump at the time of shipment.

6. All pump cable ends will then be fitted with a rubber shrink fit boot to protect cable prior to electrical installation.

F. Pump Controls – To synchronize the operation of pumps with variations of sewage level in wet well, Contractor shall provide utility approved ultrasonic transmitter to determine pump-on, lag pump on, pump-off, and high-level alarm conditions. Installation will be in accordance with the manufacturer's instructions.

1. Floats – Furnish two additional floats for high alarm and low alarm.

2. An alternator shall also be provided to change operation sequence of pumps at the completion of each pumping cycle. Provisions shall also be made for pumps to operate in parallel if level in wet well continues to rise above the "pump-on" cycle. Contractor shall furnish and install one automatic control center, equipped with individual disconnects, across-the-line magnetic starters, 3-phase, overload and phase protection, electrical alternator, automatic transfer to non-operating pump in event of overload in operating pump, overload reset, hand-off-automatic pump

operation selector switch, 24-volt control circuit transformer, and terminal board with connections for high-level alarm. All components shall be housed in a NEMA 4X enclosure. Control center shall be installed on a treated timber rack next to the station. Cables provided for pump feeders and pump controls shall be installed in conduit from control center to entrance point in wet well.

G. Alarm – A high-water alarm shall be supplied. A red flashing light shall be supplied in separate NEMA 4X enclosure for mounting at the control box. An audible alarm consisting of a weatherproof bell with automatic reset silencer switch and signal light shall be installed in addition to the flashing red light alarm.

H. Shop Drawings:

1. Contractor shall submit for review by Engineer a complete schedule and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, such as catalogs, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements. Model numbers alone will not be acceptable. Complete electrical characteristics shall be provided for all equipment.

2. All shop drawings shall be completely checked and marked accordingly with Contractor's stamp prior to submitting drawings to the Engineer for review. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Where shop drawings are "Furnished as Corrected," the reviewer has noticed deficiencies in compliance with contract specifications and drawings. It is understood corrections indicated will be incorporated by Contractor in the final product, operation and maintenance manuals and shop drawings submitted at completion of project. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by contract documents.

I. Pump Warranty – The pump manufacturer shall warrant pumps being supplied to Owner against defects in workmanship and materials for a period of five years under normal use, operation, and service. In addition, manufacturer shall replace certain parts which become defective through normal use and wear on a progressive schedule of cost for a period of five years. Parts included are the mechanical seal, impeller pump housing, wear ring, and ball bearings. The warranty shall be in published form and apply to all similar units.

J. Operation and Maintenance Manual – The pump manufacturer shall furnish Owner with a minimum of six manuals for pumps installed.

K. Provide Scada System to integrate into the overall plant Scada system. Provide equipment, conduit, and wiring as need to prove a fully functional system.

2.11 EFFLUENT PUMP STATION

Shall be vertical turbine installed in a concrete wet wall.

A. Pump and Driver Requirements

1. Type of Installation – The work shall include furnishing, installing, and testing line shaft vertical turbine pumping units and their appurtenances as indicated. Pumps shall be utilized and installed as described below. Line shaft lubrication shall be potable water.

2. Pump Drivers – Pumps shall have the type of drive units indicated.

B. Pump Performance

Pumps shall be capable of discharging quantities of water at maximum pump speed and total pump head with the minimum efficiency indicated. Total pump head in feet shall consist of the pumping level below datum and the static and friction head above datum at design capacity.

PUMPING REQUIREMENTS – PUMPS #1 & #2

Pump Conditions (Single Pump Operating)	660 GPM @ 170' TDH
Pump Conditions (Two Pumps Operating)	1,125 GPM @ 190' TDH
Minimum Shutoff Head	225 Ft
Maximum Nominal Speed	1,800 RPM
Minimum Pump Efficiency	75%
Maximum NPSH Required	16 Ft
Manufacturer	Peerless
Min. HP	40
Phase	3
Voltage	460

C. Line Shaft Vertical Turbine Pumps

Line shaft vertical turbine pumps shall be constructed in accordance with AWWA E101 except as modified. Pumps shall be designed for flanged discharge and the pump setting or location of the pump suction shall be as indicated.

1. Pump Head Assembly

Pump head assembly shall consist of the pump baseplate, the discharge head, and the driver. Head assemblies shall be of low, rigid construction arranged for bolting to concrete foundations and shall be provided with at least two eyebolts, cast lugs, or other means of securing slings to facilitate setting and lifting. Pump discharge head and baseplate shall be capable of withstanding all end and side thrusts imposed by the pump during operation and have adequate strength to resist vibration at any operating speed.

a. Pump Baseplate

Pump head baseplate shall be steel and shall serve as a sole plate for mounting the discharge head assembly.

b. Discharge Head

Discharge head shall be cast iron with 125-pound flanges. Flanges shall be designed for standard pipe connections conforming to ASME B16.1 and ASME B16.5. Surface-type discharge heads shall be designed for mounting on the baseplate or cast integrally with the baseplate. Discharge head shall be provided with a packed stuffing box with bronze lantern ring, a split gland follower, bronze follower nuts, and a grease lubricator. Discharge head shall be designed to prevent contamination of the well from the surface, and shall accommodate the required driver assembly. Space shall be provided for access to the coupling between the pump shaft and drive shaft. Pipe taps shall be provided on the discharge head as required for discharge gauge connections. Discharge head interior and exterior shall be coated with epoxy coating with a DFT of 10-14 mil.

2. Water-Lubricated Column and Shaft Assembly

Each section of the discharge column shall consist of a flanged type column pipe, line shaft, bronze bearing retainers with rubber bearings spaced not more than 10 feet on centers. Line shaft shall be Type 416 stainless steel with threaded couplings. Line shaft should be sized to operate pump without excessive distortion or vibration. Type 304 stainless steel shaft sleeves shall be furnished at each bearing location. Column pipe shall be ASTM Grade 53 B steel pipe with 150 LB flanged connections. Column pipe must be a minimum of six-inch diameter. Column pipe interior and exterior shall be coated with epoxy coating with a DFT of 10-14 mil.

3. Pump Bowl Assembly

Pump bowl assembly shall include the pump bowl, pump impeller, and the pump shaft and bearings, and may be of single stage or multistage configuration. Pump bowl exterior shall be coated with epoxy coating with a DFT of 10-14 mil.

a. Pump Bowls

Bowls shall be of close-grained cast-iron having a minimum tensile strength of 30,000 pounds per square inch, free from blowholes, sandholes, and other faults, and shall have integrally-cast vanes with smooth, streamlined water passageways. All bowl fasteners shall be Type 304 stainless steel.

b. Impellers

Impellers shall be carefully finished with smooth water passageways and shall not load the prime mover beyond the nameplate rating over the entire performance range of the pump. Impellers shall be of the enclosed type. Impellers shall be statically and dynamically balanced. Impellers shall be fabricated from bronze.

4. Pump Shafts

Shafts shall be of Type 416 stainless steel of not less than 12% chrome content, capable of transmitting the required thrust in both direction, and the total torque of the unit.

5. Bearings

Intermediate bowl shall have dual bowl bearing, utilizing one water lubricated bronze bearing and one fluted rubber bearing.

6. Basket Strainer

Suction bell shall be fitted with a Type 316 stainless steel basket strainer. Basket Strainer shall be made with integral vortex suppression baffles.

D. Manufacturer's Field Services

1. Service Center

a. The pump manufacturer shall have a factory authorized service center within 5.0 hours driving time of the project site to perform complete repair of the pump unit. The service center should have adequate equipment, inventory, and personnel to perform complete repairs and rebuilds to the pump unit. The service center shall be capable of providing 24 – 48 hours turnaround of line shaft and bearing repairs, from the time of notification of needed repairs to pumps being reinstalled and placed back in operation.

b. The service center shall have an established emergency/afterhours service protocol in place and operating 24 hours a day, 7 days a week, including nights, weekends, and holidays. This protocol shall be an established protocol and designed to specifically address the emergency needs of Municipal Customers. The service center shall have complete push-pull equipment and crews which can be onsite within eight hours of notification. The service protocol shall incorporate a 24 hours a day, 7 days a week call-in number which must be answered within 15 minutes by duty personnel with the authority to mobilize men and machinery. This capability will be demonstrated to the Engineer's and Owner's satisfactory prior to submittals being approved. Organization tables, mobilization authorities, and protocols shall be submitted for review to the Engineer. The service center shall have a minimum of three service trucks with hoists and

not less than three trained pump crews which can be mobilized at any time to ensure availability. The service center shall have full machining capability as needed to make and/or repair pumps of the size on this project.

2. Start Up Service – Pump manufacturer shall have a qualified Field Representative present for startup and training of the station. A minimum of one eight-hour day shall be provided.

2.12 CHECK VALVES

A. Shall be designed for sewage service. The valve shall be cast iron and bronze fitted. The valve shall be a spring and lever type with neoprene seat and O-Ring seals on a stainless steel valve pin, for pipes three inches and larger in diameter. For check valves smaller than three inches, the valve shall be a fully ported 150 p.s.i. rated ball check valve with a corrosion resistant phenolic base and a rubber seat. Check valve shall be of full waterway design for quiet operation and with a flow area through the valve equal to or exceeding flow area of pipe to which it is installed.

2.13 PLUG VALVES

A. Shall be fully ported and of the same diameter as pipes to which they are attached. They shall have semi-steel bodies, all metal plugs, stainless steel bearings, and be equivalent to DeZurik Series 100 eccentric valves, lever operated. All valves six inches and larger shall be equipped with gear actuator and handwheel.

2.14 FLOW METER

A. Flow Meter shall be as specified elsewhere.

2.15 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. Engineer will review all products before they are ordered by Contractor.

PART 3 – EXECUTION

3.01 CONSTRUCTION OBSERVATION

A. The pump station operation shall be tested by Contractor under the direction of Engineer. Engineer or Project Representative will have the right to require any portion of work be completed in their presence. If work is covered up after such instruction, it shall be exposed by Contractor for observation. However, if Contractor notifies Engineer such work is scheduled and Engineer fails to appear within 48 hours, the Contractor may proceed. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. All improper work shall be reconstructed. All materials not conforming to requirements of specifications shall be removed from the work upon notice being

received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

B. Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

C. It will also be required by Contractor to keep accurate, legible records of the location of all appurtenances. These records will be prepared in accordance with "Record Data and Drawings" paragraph in the Special Conditions. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.02 PARTIAL ACCEPTANCE OF THE WORK

A. Owner reserves right to accept and use any part of the work. Engineer shall have power to direct on what line the Contractor shall work and order thereof.

3.03 RECORD DATA

A. It will be required of the Contractor to keep accurate, legible records, locating all as-built conditions. These records will be made available to Engineer before final review for incorporation into the Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.04 AIR RELEASE VALVE

A. The installation of valve shall be in accordance with standard drawings.

3.05 PUMPING STATION

A. Install pumps including fittings, brackets, discharge piping, check valve to basin rail assembly, plug valve, and lifting device according to manufacturer's recommendation.

B. Contractor shall provide, at minimum, spare parts to include but not limited to:

1. One Spare VFD as a pump starter.

2. One of each seal assemblies.

3. One complete set of bearings.

4. One set of wear rings.

5. One of each type relay.

6. One pump alternator.

7. One float switch with cable.

8. One of each type pilot light.

9. One box of each type lamp.

3.06 STATION STARTUP, INITIAL TESTING, AND OPERATION

A. Notify Engineer personnel five working days prior to flow rate testing.

B. Hydraulically test station to performance requirements.

C. Correct failures during test by repairing or replacing malfunctioning parts or equipment of faulty workmanship, regardless of cause, within 24 hours.

D. After correcting failures caused by defective equipment, material, or faulty workmanship, retest until failures are eliminated.

E. Confirm general sequencing of pump and float operations at basin and control panel are in accordance with performance requirements and Utility requirements.

F. Adjust pumps and control panel system to conform to performance requirements.

G. Document and certify startup results in start-up report.

3.07 MANUFACTURER'S FIELD SERVICE

A. Furnish factory trained representative and field technical assistance during the following periods of pumping station installation:

1. Unloading of station materials and components.

2. Start-up, testing, and demonstration of station systems pump, and control panel.

3.08 MANHOLES

A. Manholes shall be constructed where shown on the drawings or where directed by Engineer. The channel in bottom of manholes shall be smooth and properly rounded. Special care must be exercised in laying the channel and adjacent pipes to grade. Manhole top elevations shall be greater than or equal to the 50 year flood elevation, unless watertight covers are provided. Tops of manholes outside of roads shall be built to grades one inch above ground surface in developed areas and six inches above ground surface in undeveloped areas unless otherwise shown on the plans. Manholes in roads shall be built to grades designated by the Engineer. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured tongue or groove; or cracked walls will be subject to rejection by Engineer for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection.

B. No leaks in any manhole will be acceptable. All repairs made from inside the manhole shall be made with mortar composed of one part Portland cement and two parts clean sand. The mixing liquid shall be straight bonding agent equivalent to "Acryl 60."

3.09 STONE BEDDING

A. Where, in the Engineer's or Geotechnical Consultant's opinion, subgrade of pipe trench is unsuitable material, Contractor shall remove unsuitable material to a depth determined by Engineer or Geotechnical Consultant and furnish and place stone backfill in trench to stabilize subgrade. Presence of water does not necessarily mean stone backfill is required. If well points or other types of dewatering will remove the water, Contractor shall be required to completely dewater trench in lieu of stone backfill. Stone bedding will be limited to areas where well pointing and other conventional methods of dewatering will not produce a dry bottom. Stone shall be placed four feet wider than the outside diameter of pipe. The pipe shall be carefully bedded in stone as specified, or in accordance with manufacturer's recommendations.

3.10 SAND BEDDING

A. Where, in the Engineer's or Geotechnical Consultant's opinion, character of soil is unsuitable for pipe bedding, even though dewatered, additional depth of excavation as determined by Engineer or Geotechnical Consultant shall be made and replaced with clean sand furnished by Contractor.

3.11 DEFLECTION

A. It is the Contractor's responsibility to assure backfill is sufficient to limit pipe deflection to no more than 5%. When flexible pipe is used, a deflection test shall be made by Contractor on the entire length of installed pipeline, not less than 30 days after completion of all backfill and placement of any fill. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 95% of the inside pipe diameter. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 °F, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of 70,000 p.s.i. or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on opposite end of shaft shall produce compression throughout remote end of ball, cylinder, or circular section. Circular sections shall be spaced so distance from the external faces of front and back sections shall equal or exceed diameter of circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through by hand or by being flushed through with water, shall be cause for rejection of individual run. When a deflection device is used for the test in lieu of a ball, cylinder, or circular sections described, such device shall be acceptable to Engineer prior to use. Device shall be sensitive to 1.0% of diameter of pipe being measured and shall be accurate to 1.0% of indicated dimension. Installed pipe showing deflections greater than 5% of the normal diameter of pipe shall be retested by a run from opposite direction. If retest also fails, the suspect pipe shall be repaired or replaced at no cost to Owner.

3.12 LEAKAGE

A. In no stretch of sewer between any two adjoining manholes shall infiltration/exfiltration exceed 25 gallons per day per inch of pipe diameter per mile of pipe. In case leakage exceeds this amount, the sewer shall not be accepted until such repairs and replacements are made to comply with above requirements. Such corrections will be made at the Contractor's expense. All visible leaks shall be repaired, regardless of the amount of leakage.

B. Lines shall be tested for leakage by low-pressure air testing, infiltration tests, or exfiltration tests, as appropriate. Low-pressure air testing for PVC pipe shall be as prescribed in ASTM F 1417. Prior to infiltration or exfiltration tests, trench shall be backfilled up to at least the lower half of pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When water table is two feet or more above top of pipe at upper end of pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to Engineer. When Engineer determines infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so a head of at least two feet is provided above both water table and top of pipe at upper end of pipeline to be tested. The filled line shall be allowed to stand until pipe has reached its maximum absorption, but not less than four hours. After absorption, the head shall be re–established. The amount of water required to maintain this water level during a two-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Owner.

C. The Contractor shall furnish equipment and plugs and subject force mains to hydrostatic tests at 100 p.s.i. for a period of two hours. Any leaks shall be located and repaired. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. No pipe installation will be accepted until leakage during pressure test is less than the number of gallons listed for each 1000–feet of pipe tested:

6 inches & less – 0.9 gallons	12 inches – 1.80 gallons
8 inches – 1.20 gallons	14 inches – 2.10 gallons
10 inches – 1.50 gallons	16 inches – 2.40 gallons

3.13 CLEANING AND ACCEPTANCE

A. Before acceptance of sewer system, it shall be tested and cleaned to the satisfaction of Engineer. Where any obstruction is met, Contractor will be required to clean sewers by means of rod and swabs or other instruments. The pipe line shall be straight and show a uniform grade between manholes. The Engineer shall check lines by lamping or other methods to determine final acceptance.

3.14 CLOSING PIPE

A. When work or pipe installation is suspended, either for the night or at other times, end of sewer must be closed with a tight cover. Contractor will be held responsible for keeping the sewer free from obstruction.

3.15 PUMPING STATIONS

A. The precast sections shall be carefully handled and placed in position undamaged. Spalled areas, cracks, or exposed reinforcing in any section shall be cause for rejection of a section. Damaged elements shall be promptly removed from the job–site.

The structure shall be installed plumb and level by Contractor on a prepared, evenly distributed and level, minimum 12-inch-thick crushed–stone bed. Joints between sections shall be sealed with butyl–rubber or neoprene sealant. Asphaltic–based material or similar products shall not be used. The sealant shall be applied in accordance with sealant manufacturer's recommendation. Leakage through joints or around pipes will not be acceptable. Grout used at construction joints and around pipes shall be Five Star brand non–shrink grout or an acceptable equivalent.

Excavation shall be accomplished in a manner as required to protect adjacent property and utilities and for safety. Backfilling shall be accomplished as soon as practicable after the structure has been placed and sealed. Backfilling shall be achieved by placing material in equal lifts (maximum two feet) and compacting each lift to maintain stability and plumbness of the structure. Backfill material shall be a select granular material with a maximum plasticity index (P.I.) of 12. Compaction shall be accomplished by means of mechanical tamping to 98% of maximum laboratory density at optimum moisture when tested by ASTM D 6938. During backfilling operation and until its completion, the wet well sections shall be maintained in an absolute plumb position. To prevent structure from possibly becoming buoyant in hydrostatic or flooded conditions, Contractor shall take necessary steps to avoid flotation of the structure.

Drawings indicate the general arrangement and location of electrical equipment, conduit, piping, transformer, and generator. Installation and location of these items shall be coordinated with the pump station operating personnel.

3.16 FORCE MAIN

A. Ductile Iron Force Main shall be installed in accordance with AWWA C 600.

B. PVC Force Main shall be installed in accordance with ASTM D 2774.

C. Crossings with water mains shall conform to South Carolina Department of Health and Environmental Control's Bureau of Water Standards for Wastewater Facility Construction: Regulation 61–67.

END OF SECTION

INDEX TO

SECTION 33 41 01

STORM DRAIN PIPING

SECTION 33 41 01

STORM DRAIN PIPING

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO):

a. M36M, Standard Specification for Corrugated Steel Pipe, Metallic–Coated, for Sewers and Drains.

b. M 190M, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.

c. M196M, Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.

2. ASTM International (ASTM):

a. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.

b. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

3. South Carolina Department of Transportation Standard Specifications, latest edition (SCDOT Standard Specifications.)

1.02 SUBMITTALS

A. Informational Submittals: Manufacturer's Certification of Compliance.

PART 2 – PRODUCTS

2.01 PIPE AND FITTINGS

A. As specified in the Data Sheets following "End of Section" and in accordance with SCDOT Standard Specification.

PART 3 – EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.

2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.

3. Pipe invert may deviate from line or grade up to 0.1 foot provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.

4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.

5. Prevent entry of foreign material into gasketed joints.

6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

7. Storm pipes shall be installed in accordance with SCDOT Standard.

B. Concrete Closure Collars: Only use concrete closure collars where shown or authorized by Engineer.

3.02 SUPPLEMENTS

A. The supplement listed below is part of this Specification.

1. Data Sheet:

Number	**Title**
–.05	Reinforced Concrete

DATA SHEET

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Pipe	In accordance with South Carolina Department of Transportation Standard Specification for reinforced concrete pipe. Class III and Class IV.

END OF SECTION

INDEX TO

SECTION 40 05 15

PIPE HANGERS AND SUPPORTS

SECTION 40 05 15

PIPE HANGERS AND SUPPORTS

PART 1––GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. GENERAL: This section specifies hangers and supports for all exposed piping systems specified in Section 40 27 05. This section does not include pipe supports for fire sprinkler systems or seismic restraints.

2. SCOPE OF CONTRACTOR DESIGN: The Contractor shall provide the services of a "Design Professional" as specified in paragraph 40 27 05–1.01 A to conduct all necessary piping and support design for exposed piping.

   Whether a design or general arrangement is shown or not, Contractor's Design Professional shall design all pipe supports, anchorage, restraints and expansion control, as specified. Where a conflict arises, Contractor's Design Professional shall present any conflict to Construction Manager for resolution.

   The Design Professional's work shall incorporate design criteria and other conditions as specified herein, in related sections and as shown on the drawings.

   Additional requirements are specified in related sections.

3. SCOPE OF WORK BY DESIGN ENGINEER: Design Engineer has undertaken design details for supports and anchors for: selected discharge and intake manifolds; selected special installation requirements; and, selected piping 48–inches and larger. Contractor's Design Professional shall incorporate these features into the Contractor's design.

   Where shown, Design Engineer has also provided guidance in the form of general arrangements that may include specific types of supports or anchorage details. In addition, allowable anchor points and load capacities for potential support structures are shown or otherwise described herein.

B. OPERATING CONDITIONS:

The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:

1. Hot Systems
   A – 1. 120 degrees F to 450 degrees F
   A – 2. 451 degrees F to 750 degrees F
   A – 3. Over 750 degrees F

2. Ambient Systems
   B. 60 degrees F to 119 degrees F

3. Cold Systems
   C – 1. 33 degrees F to 59 degrees F
   C – 2. –20 degrees F to 32 degrees F

C. HANGER AND SUPPORT SELECTION:

The Contractor shall cause the pipe hangers and supports to be designed and selected by the Design Professional retained under the provisions of paragraph 40 27 05–1.01 A 2.. This provision, however, shall not relieve the Contractor of overall responsibility for this portion of the work. Hanger and support selection shall be based on the following:

1. The Contractor shall select pipe hangers and supports as specified in the project manual. Selections shall be based upon the pipe support classifications specified in MSS–SP 69, the piping insulation thickness specified in Section 40 27 05.09, and any special requirements which may be specified in the project manual.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.

3. Where a particular pipe support arrangement is shown, a design incorporating that arrangement shall be used.

4. Where a particular pipe support design is shown, that design shall be used.

5. Pipe supports shall be spaced such that pipe span deflections do not exceed 0.1–inch.

6. Pipe support design shall incorporate applicable criteria of ASME or other recognized standard.

7. The pipe hanger and support system shall be coordinated with the seismic restraint system specified under Section 40 05 15.10.

8. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:

   a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

   b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

   c. Reaction forces due to test and operational conditions.

d. Reaction forces due to the operation of safety, relief, or other valves.

e. Wind, snow or ice loadings on outdoor piping.

f. Supports shall be designed to prevent transfer of the weight of piping, valves and piping appurtenances to equipment piping connections. All supports adjacent at equipment connections to piping systems shall have provisions for vertical and horizontal adjustment. Two flexible piping connections not less than one pipe diameter apart shall be provided between piping supports and any equipment piping connection.

9. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.

10. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.

11. Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.

12. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.

13. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

14. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper–plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.

15. Stock hanger and support components shall be used wherever practical.

16. Fiberglass framing channel shall be provided where specified.

The following structural criteria shall also be applied:

1. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

2. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.

3. Where critical support load requirements have been identified, limiting structural load requirements are shown.

4. Pipe support hangers, brackets etc. shall be of suitable capacity and shall be appropriate to the individual structural member that is used to support

the pipe.

5. The structural integrity of existing and new members shall in no way be impacted by the placement of connections for pipe supports. For example, the tension reinforcement in reinforced concrete members shall not be impacted in any way by the placement of fasteners for pipe supports.

6. Spacing and arrangement of hangers supporting pipe shall be provided in such a manner that the loads from the pipes on existing and new structural members shall be quasi–uniform. These quasi–uniform loads shall not exceed the allowable design loads for mechanical equipment as shown on existing (not necessarily contract) drawings and as listed under Design Live Loads in the General Notes.

7. For new construction, unless otherwise shown, pipe may be supported from nearest structural element (floor, ceiling, or wall). The Design Loads for mechanical equipment, as listed in the General Notes sheet of the Structural drawings shall not be exceeded.

8. The loads and specific attachment requirements for pipe supports on new concrete Tees shall be coordinated with the Tee manufacturer and incorporated into the design of the Tees.

9. Unless otherwise specified, pipe supports from existing Tees or other roof types shall not be constructed without an evaluation of capacity and appropriate design from Contractor's Design Professional.

The following, project–specific criterion shall also be applied:

1. The spacing for pipe hangers shall not be less than 5 feet and shall not exceed 375 lbs of load for all existing pre–cast, Double Tee roof elements. For hangers off flanges of existing Tees, a washer shall be provided having minimum dimensions of 1/4 inch thick by 4 inch long and 4 inch wide. The design and projection of those hangers above the roof shall be coordinated with the architectural roofing system.

2. For sodium hydroxide systems, pipe supports shall be 60 percent closer than the maximum spacing indicated for plastic piping for water service.

1.02 QUALITY ASSURANCE

A. REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective

date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design – 9th Ed.
FEDSPEC WW–H–171e–78	Hangers and Supports, Pipe
MFMA–2–91	Metal Framing Standards Publication
MSS SP–69–91	Pipe Hangers and Supports – Selection and Application
MSS SP–58–93	Pipe Hangers and Supports – Materials, Design and Manufacture

B. DESIGN:

The Contractor shall cause the design of pipe hanger and support systems to be developed in conjunction with preparation of the design seismic restraints and expansion control system by the Design Professional selected in accordance with Paragraph 40 27 05–1.01 A. The pipe system drawings specified in paragraph 40 27 05–2.04 shall show the hanger and support locations as well as the details of the seismic restraints and expansion control systems. The pipe hanger and support design drawings and calculations shall be prepared and signed by the design professional and shall bear the Design Professional's registration seal.

PART 2––PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe supports and components shall be manufactured by B–Line, Carpenter & Patterson, Kin–Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP–69 and FEDSPEC WW–H–171e. Pipe support materials shall conform to the requirements of MSS SP–58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA–2.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be hot–dip or mechanically galvanized after fabrication. Nuts, bolts and washers may be zinc–plated except for those subject to moisture or corrosive atmosphere, as specified in paragraph 16000–1.05 B as shown on the drawings, which shall be type FRP or 304 stainless steel. Exterior pips supports shall be FRP or stainless steel.

B. PIPE HANGERS AND SUPPORTS:

Pipe hangers and supports of dissimilar metals than pipe shall be insulated. Pipe hangers and supports shall support pipe in the manner recommended by the pipe manufacturer and/or applicable building or piping codes.

C. RACK AND TRAPEZE SUPPORTS:

Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

D. STRUCTURAL ATTACHMENTS:

1. TYPE A – MALLEABLE IRON CONCRETE INSERT: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.

2. TYPE B – SIDE BEAM BRACKET: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B–Line B3062, or equal.

3. TYPE C – MALLEABLE BEAM CLAMP WITH EXTENSION PIECE: Clamp and extension piece shall be malleable iron, tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B–Line B3054, or equal.

4. TYPE D – STEEL BEAM CLAMP WITH EYE NUT: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.

5. TYPE E – FRAMING CHANNEL POST BASE: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B–Line B280, or equal. Double channel: Unistrut P2073A, B–Line B281, or equal.

6. TYPE F – WELDED BEAM ATTACHMENT: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B–Line B3083, Grinnell Fig. 66, or equal.

7. TYPE G – WELDED STEEL BRACKET: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.

8. TYPE H – CAST IRON BRACKET: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.

9. TYPE J – ADJUSTABLE BEAM ATTACHMENT: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B–Line B3082, or equal.

10. TYPE K – DOUBLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5. Cantilever

bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B–Line B297–12 through B297–36, or equal.

11. TYPE L – SINGLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B–Line B198–6, B198–12, B196–18 and B196–24, or equal.

12. TYPE M – WALL MOUNTED CHANNEL: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5.

13. TYPE N – PIPE STANCHION FLOOR ATTACHMENT: Baseplate shall be carbon steel with 1/2 inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.

14. TYPE Q – CONTINUOUS CONCRETE INSERTS: shall be 1 5/8 by 1 3/8 Channel, cold formed 12 Ga. steel conforming to ASTM A 1001, stainless steel GR 33 or ASTM GR 33 A., hot dip galvanized conforming to ASTM A123 or A153, UNISTRUT P3200 Series, or approved equal.

E. ACCESSORIES:

1. HANGER RODS: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.

2. WELDLESS EYE NUT: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B–Line B3200, or equal.

3. WELDED EYE ROD: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B–Line B3211, or equal.

4. TURNBUCKLE: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B–Line B3202, or equal.

5. FRAMING CHANNEL: Framing channel shall be 1 5/8 inches square, roll formed, 12–gage carbon steel. Channel shall have a continuous slot along one side with in–turned clamping ridges. Single channel: Unistrut P1000, B–Line B22, or equal. Double channel: Unistrut P1001, B–Line B22A, or equal. Triple channel: Unistrut P1004A, B–Line B22X, or equal.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation specified in 40 27 05.09. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems.

Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

A. STANDARD SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

B. VAPOR BARRIER SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vapor tight connection to pipe insulation vapor barrier.

2.04 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Hanger and support locations and components shall be indicated on the piping layout drawings required by paragraph 40 27 05–2.04.

2. Design Professional's reports as specified in paragraph 40 05 15–3.05.

PART 3––EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

The Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum

span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.

At least one hanger or support shall be located within 2 feet from a pipe change in direction.

The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.
Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

The Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

3.04 ANCHOR BOLTS

Anchor bolts in new concrete shall be cast in place.

3.05 INSPECTION AND CERTIFICATION

The design professional retained by the Contractor under the provisions of paragraphs 40 27 05–1.02 C and 40 05 15–1.02 B shall inspect the pipe hangers, support and restraint systems at not less than bi–weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed pipe hanger, support and restraint system before the Owner assumes beneficial occupancy and provide written certification, without any qualification statements, that the installation conforms to the design professional's design and the Contract Document requirements as may be described in other Sections or on the drawings. All reports shall bear the Design Professional's seal and signature in accordance with the laws, rules and regulations of the state.

SECTION 40 05 15

APPENDIX A

PIPE HANGERS AND SUPPORTS TABLES

TABLE A - SUPPORT SPACING AND ALLOWABLE ROD LOADS						
NOMINAL PIPE SIZE (INCHES)	SUPPORT ROD SIZE AND MAXIMUM LOAD PER ROD - SEE NOTES 1 AND 2		MAXIMUM SUPPORT SPACING (FEET)			
	ROD SIZE (INCHES)	MAX LOAD (POUNDS)	STEEL	COPPER	PLASTIC SEE NOTE 4	CAST IRON SEE NOTE 5
3/8 TO 3/4	3/8	610	5	5	CONTINUOUS	---
1	3/8	610	5	5	5	---
1-1/4	3/8	610	5	5	5	---
1-1/2	3/8	610	5	5	5	---
2	3/8	610	10	5	5	12 FEET FOR PRESSURE PIPE 10 FEET FOR SOIL PIPE
2-1/2	3/8	610	10	10	5	
3	3/8	610	10	20	5	
4	1/2	1130	10	20	5	
6	5/8	1810	15	20	5	
8	3/4	2710	15	20	5	
10	3/4	2710	20	---	5	
12	1	4960	20	---	10	
14	1	4960	20	---	---	
16	1	4960	20	---	---	
18	1	4960	20	---	---	
20	1-1/4	8000	20	---	---	
24	1-1/4	8000	20	---	---	
30	1-1/2	11630	20	---	---	

TABLE A NOTES:

1. DESIGN WEIGHT SHALL BE TWICE THE WEIGHT OF THE PIPE FULL OF WATER PLUS THE WEIGHTS OF VALVES, FITTINGS, INSULATING MATERIALS AND SUSPENDED HANGER COMPONENTS ON THE RUN OF PIPE BEING SUPPORTED.

2. ROD SIZES SHOWN ARE FOR THE SUPPORT OF A SINGLE PIPE. WHEN SUPPORTING MORE THAN ONE PIPE, ROD SHALL BE SIZED USING DESIGN WEIGHTS (SEE NOTE 1) TO DETERMINE THE TOTAL DESIGN LOAD. THE TOTAL DESIGN LOAD SHALL NOT EXCEED THE MAXIMUM LOADS IN THE TABLE ABOVE.

3. PIPE SHALL NOT HAVE POCKETS FORMED IN THE SPAN DUE TO SAGGING OF THE PIPE BETWEEN SUPPORTS CAUSED BY THE WEIGHT OF THE PIPE, MEDIUM IN THE PIPE, INSULATION, VALVES AND FITTINGS.

4. SPAN SHOWN IS FOR SCHEDULE 80 PVC PIPE AT 100°F. SPANS FOR OTHER PLASTICS, OTHER PVC PIPE SCHEDULES AND PIPES AT HIGHER TEMPERATURES SHALL BE SHORT- ENED IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS. ``CONTINUOUS" MEANS PIPE SHALL BE IN UNISTRUT OR SIMILAR CHANNEL.

5. PROVIDE A MINIMUM OF ONE HANGER PER PIPE LENGTH, WITHIN 4-INCHES OF THE BELL.

6. PIPE HANGER AND SUPPORT SELECTION SHALL BE IN ACCORDANCE WITH TABLE B (M2302) AND SPECIFICATION SECTION 15096.

TABLE B HANGER AND SUPPORT SELECTIONS

SYSTEM TEMP RANGE DEG F	INSULATION NOTE 1	PIPE ATTACHMENTS									BUILDING STRUCTURAL ATTACHMENTS			
		HORIZONTAL								VERTICAL	STEEL AND/OR MALL. IRON			
		STEEL STRAPS	STEEL BANDS	STEEL CLAMPS	CAST IRON HANGING ROLLS	CAST IRON SUPPORTING ROLLS	STEEL TRAPEZES AND RACKS	THERMAL HANGER SHIELDS	STEEL OR CAST IRON STANCHIONS	STEEL RISER CLAMPS	INSERTS	BEAM CLAMPS	WELDED AND BOLTED ATTACHMENTS	BRACKETS
HOT A-1 120 TO 450	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	10					
HOT A-2 451 TO 750	COVERED	13	1	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	NONE	3	NONE	NONE	20, 21	NONE	NONE					
HOT A-3 OVER 750	COVERED	13	1	3 (ALLOY)	4, 5	8	20, 21	SEE SPEC	10	11, 12	NONE	C, D	F, J, M	B, G, H, K, L
	BARE	13	NONE	3 (ALLOY)	NONE	NONE	20, 21	NONE	NONE					
AMBIENT B 60 TO 119	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	9,10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	9,10					
COLD C-1 33 TO 59	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2, 3	3	4, 5	8	20, 21	NONE	10					
COLD C-2 -2 TO 32	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	1, 2, 3	3	4, 5	8	20, 21	NONE	10					

TABLE B NOTES:

1. HANGERS ON INSULATED SYSTEMS SHALL INCORPORATE THERMAL HANGER SHIELDS.
2. HANGER AND SUPPORT SPACING SHALL BE IN ACCORDANCE WITH TABLE A (M2301).

TABLE C
SEISMIC RESTRAINT SPACING

NOM. PIPE SIZE	MAXIMUM SPAN BETWEEN BRACES		BRACE TYPE	MAXIMUM BRACE LENGTH
	LATERAL BRACE (FEET)	LONGITUDINAL BRACE (FEET)		
2	40	80	A1	9'-4"
2-1/2	40	80	A1	9'-4"
3	40	80	A1	9'-4"
4	40	80	A1	9'-4"
6	40	80	A1	9'-4"
8	40	40	A1	9'-4"
10	40	40	A1	9'-4"
12	40	40	A2	10'-0"
14	30	30	A2	10'-0"
16	25	25	A2	10'-0"
18	20	20	A2	10'-0"
20	16	16	A2	10'-0"
24	10	10	A2	10'-0"

(S) - STANDARD WALL

END OF SECTION

INDEX TO

SECTION 40 05 15.10

SEISMIC RESTRAINTS FOR PIPING

SECTION 40 05 15.10

SEISMIC RESTRAINTS FOR PIPING

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies seismic restraints for bracing all piping systems specified in Section 40 27 05. This section does not include seismic restraints for fire sprinkler systems.

B. DEFINITIONS:

1. Longitudinal direction—direction parallel to the pipe axis.
2. Lateral direction—direction perpendicular to the pipe axis.

C. OPERATING CONDITIONS:

The seismic restraints specified in this section are provided to resist pipe movements and loads occurring as a result of an earthquake or other seismic event.

All piping systems shall be provided with seismic restraints conforming to governing state and local codes. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

D. RESTRAINT SELECTION:

1. The Contractor shall select, locate and provide seismic restraints for piping in accordance with this section. As set forth in Paragraph 40 27 05–1.01 A, this work shall be the product of a Design Professional retained by the Contractor.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.

3. Seismic restraints may be omitted from the following installations:

   a. Gas piping less than 1–inch inside diameter.
   b. All other piping less than 2 1/2–inch inside diameter.

4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.

6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper–plated, rubber, plastic or vinyl coated, or stainless steel restraint components.

7. Branch lines shall not be used to brace main lines.

8. Seismic bracing shall not limit the expansion and contraction of the piping system.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, 9th Edition
MFMA–2	Metal Framing Standards Publication
MFMA–101	Guidelines for the Use of Metal Framing
MSS SP–58	Pipe Hangers and Supports – Materials, Design and Manufacture
MSS SP–69	Pipe Hangers and Supports – Selection and Application

Reference	Title
MSS–SP–89	Pipe Hangers and Supports – Fabrication and Installation Practices
SMACNA	Seismic Restraint Manual—Guidelines for Mechanical Systems

B. DESIGN:

The seismic restraint system shall be designed by the Design Professional retained under Paragraph 40 27 05–1.01 A. Seismic restraint details shall be designed in conjunction with preparation of pipe system hangers and drawings specified in paragraph 40 27 05–2.04. All drawings and work product for the seismic restraint system shall bear the design professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

PART 2 – PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B–Line, Kin–Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe restraint materials, design, manufacture, installation, and application shall conform to the requirements of MSS SP–58, MSS–SP–69, MSS–SP–89, MFMA–1, and MFMA–101.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, restraints manufactured of iron or steel, including braces, pipe and structural attachments, shall be hot–dip galvanized after fabrication. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc–coated except for those subject to moisture or corrosive atmosphere, which are listed in paragraph 26 05 00–1.05 B; those compounds shall be type 304 stainless steel. Also listed in paragraph 26 05 00–1.05 B are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe supports, anchor and seismic brace components (not just fittings and accessories) shall be made of fiberglass.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in paragraph 40 05 15–2.03. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

2.04 PRODUCT DATA

The following information shall be submitted:

1. Seismic restraint system drawings and calculations as specified in paragraph 40 05 15.10–1.02 B.

2. Seismic restraint locations and legend as specified in paragraph 40 05 15.10–3.01.

3. The Design Professional's reports and certification of final installation as specified in paragraphs 40 27 05–1.01 A and 40 05 15.10–3.03.

PART 3––EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

The first seismic restraint on a piping system shall be located not more than 10 feet from the main riser, entrance to a building or piece of equipment.

Ductile and cast iron pipe shall be braced on each side of a change in direction of 90 degrees or more. Joints in risers shall be braced or stabilized between floors.

No–hub and bell and spigot cast iron soil pipe shall be braced longitudinally every 20 feet and laterally every 10 feet.

Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

Seismic restraint locations and components shall be indicated on the piping layout drawings required by paragraph 40 27 05–2.04. The drawings shall bear a legend giving load information and restraint component selection at each restraint location and shall be sealed and signed by the Design Professional retained by the Contractor for design of the pipe hanger and support system under the provisions of paragraphs 40 27 05–1.02 C and 40 05 15.10–1.02 B.

3.02 INSTALLATION

Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

Lateral and longitudinal bracing shall be installed between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of AISC M011. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

Embedded anchor bolts shall be used instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 40 27 05–1.01 A and 40 05 15.10–1.02 B shall inspect the seismic restraint system at not less than bi–weekly intervals during construction and furnish the Engineer with monthly reports. The Design Professional shall inspect the completed seismic control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 15 requirements.

END OF SECTION

INDEX TO

SECTION 40 05 15.15

EXPANSION CONTROL FOR PIPING

SECTION 40 05 15.15

EXPANSION CONTROL FOR PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies expansion control for the piping systems specified in paragraph 40 05 15.15-1.01 C. This section addresses pipe anchorage, pipe guides, and expansion control by either expansion joints or pipe deflection.

B. DEFINITIONS:

Term	Definition
Expansion joint	Any device containing one or more bellows used to absorb dimensional changes.
Main anchor	An attachment between a structure and a pipe which must withstand the full pipeline thrust due to pressure, pipe bending, pipe compression, flow, spring forces, pipe and contents weight and other pipe forces.
Intermediate anchor	An attachment between a structure and a pipe which withstands the same forces as a main anchor except the pressure forces.
Sliding anchor	An attachment between a structure and a pipe which absorbs forces in one direction while permitting motion in another.
Pipe guide	A device fastened to a structure, which permits the pipeline to move freely in only one direction, along the axis of the pipe.
Pipe section	That portion of pipe between two anchors.
Planar pipe guide	A device fastened to a structure, which permits transverse movement or bending of the pipeline in one plane.
Lateral direction	Direction perpendicular to the pipe axis
Longitudinal direction	Direction parallel to the pipe axis

C. OPERATING CONDITIONS:

Expansion control as specified in this section shall be provided to control pipe movements and loads occurring as a result of pipeline temperature changes.

Those piping systems listed in the following table shall be provided with expansion control conforming to good engineering practice.

Piping system	Minimum temperature, degrees F	Maximum temperature, degrees F
A, AA, BA, CA, IA, SA	17 (exterior –20)	300 (exterior 200)
CS, DS, LSG, MSG (and combinations)	30 (exterior –20)	120
EE	-20	1000
GRR/S	-20	200
HW, HRR/S	70	230
Unlisted Piping (exterior)	-20	120
Unlisted Piping (interior)	30	120

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
EJMA-93	Standards of the Expansion Joint Manufacturers Association, Inc., Sixth Edition, 1993
EJMA-85	A Practical Guide to Expansion Joints, Copyright 1985, Expansion Joint Manufacturers Association, Inc.

B. DESIGN:

The expansion control system shall be designed by the Contractor's Design Professional selected under paragraph 40 27 05-1.01A. Expansion control details shall be designed in conjunction with preparation of pipe system hangers and

seismic restraint systems drawings specified in paragraph 40 27 05-2.04. The resulting drawings and work product for the expansion control system shall bear the Design Professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. DESIGN GUIDELINES:

The Design Professional shall use the following guidelines in preparation of the designs and calculations specified in paragraph 40 05 15.15-1.02 B:

1. The difference between the minimum and maximum temperatures listed in the table in paragraph 40 05 15.15-1.02 C shall be used for calculating pipe expansion.

2. Published coefficients of thermal expansion for pipe materials shall be used for the listed temperature range. The source of the coefficients of expansion used in the calculations shall be included with the information provided as Product Data.

3. Expansion control systems shall be designed for maximum reliability. Unless otherwise indicated on the Drawings, "L", "U", or "Z" bends shall be employed to control expansion in preference over expansion joints.

4. Expansion control systems using pipe bends shall be designed to limit bending stress in the pipe associated with deflection at the worst case temperature difference. The maximum allowable bending stress shall be 1/3 of the yield stress for the pipe material. If loading conditions or uncertainties warrant, a lower allowable stress value shall be used. A recognized pipe bending stress calculation method and documentation supporting its use shall be provided as Product Data.

5. Expansion control design for expansion joints shall conform to the guidelines given in the Standards of The Expansion Joint Manufacturers Association, Inc. (EJMA).

6. If the Design Professional chooses to use expansion control or pipe support methods that involve higher loadings on the structure than are specified and/or shown on the drawings, the Construction Manager shall be notified in the submittal required in paragraph 40 27 05-2.04. The requested loads shall be listed and the Construction Manager will redesign the structure as necessary at the Contractor's expense.

7. The test pressures listed in the PIPESPEC sheets shall be used when calculating pressure forces.

8. Pipe guides or planar pipe guides shall be provided to control the movement of pipes when "L", "U", or "Z" bends are used for expansion control. The guides shall be located as indicated in EJMA standards. An alternative recognized standard may be used for this purpose only upon approval by the Construction Manager.

9. For piping systems with potentially large loads, recommended main anchor locations are shown on the drawings. Intermediate anchors shall be provided as needed. Maximum forces that the structure can withstand at the main anchor points are noted on the drawings. Anchors shall be designed to attach to the structure and solidly to the pipe. Pipe clamps or U-bolts are not allowed unless they are designed to withstand the forces imposed upon the anchor and have stops welded to the pipe so that the pipe cannot slip in the anchor.

10. Anchors and guides shall be coordinated with the pipe support systems specified in Section 40 05 15 and seismic restraints specified in Section 40 05 15.10.

11. The design of the expansion control, pipe support and seismic restraints for the listed piping systems shall be integrated to provide maximum flexibility for maintenance access to equipment, appurtenances such as valves etc., and to the pipe itself.

12. The piping layout indicated shall be reviewed in relation to, surrounding structures, adjacent piping and equipment before selecting the anchors, guides, and expansion control method to be used at each point.

13. There shall be no metal-to-metal contact between a pipe and restraint component of dissimilar metals.

14. Branch lines shall not be used to anchor main lines.

15. For elevated pipe sections, fabricated support frames or other appropriate structures shall be designed to withstand the specified loads plus gravity and seismic loads. The supports shall be designed to provide access to equipment, walkways, gates, and other piping.

1.03 SUBMITTALS

The following information shall submitted for approval:

1. Expansion control schedules as specified in paragraph 40 05 15.15-3.01.

PART 2 - PRODUCTS

2.01 MATERIALS

Unless otherwise specified, anchors, and guides shall be manufactured of iron or steel, including braces, pipe and structural attachments, and shall be hot-dip galvanized after fabrication. Supports cast integrally with cast iron fittings are specifically prohibited for use in any application where shear forces may be imposed on the support. Structural anchors may be fabricated from structural steel and coated. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in paragraphs 26 05 00-1.05 B and C, which shall be Type 304 stainless steel. Also listed in paragraph 26 05 00-1.05 C are corrosive areas specifically requiring fiberglass materials. In

those areas, all pipe support, anchor and brace components (not just fittings and accessories) shall be made of fiberglass.

2.02 PRODUCT DATA

The following product data shall be Submitted for Approval:

1. Anchor bolt calculations.

2. The Design Professional's reports and final certification, as specified under paragraph 40 05 15.15-3.03.

PART 3 - EXECUTION

3.01 EXPANSION CONTROL SCHEDULES

A. GENERAL:

Anchor, guide, and expansion joint locations shall be indicated on the piping layout drawings required by paragraphs 40 27 05-2.04 and 40 05 15.15-1.02 B. In addition, schedules shall be prepared as specified below.

B. ANCHORS:

The anchor schedule shall list as a minimum:

1. Anchor Point Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Forces
6. Load, pounds
7. Direction
8. Anchor Description
9. Remarks

C. GUIDES:

The guide schedule shall list as a minimum:

1. Guide Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Guide Description
6. Remarks

D. EXPANSION JOINTS:

The expansion joint schedule shall list as a minimum:

1. Expansion Joint Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Movement, inches
   a--Lateral movement
   b--Compression movement
   c--Extension movement
   d--Angular movement
6. Maximum Spring Force, pounds
7. Test Pressure, psig
8. Pressure Force, pounds
9. Total Forces
10. Load, pounds
11. Direction
12. Expansion Joint Description
13. Special Features
14. Remarks

3.02 INSTALLATION

The Contractor shall install the expansion control system in accordance with the drawings required in paragraph 40 05 15.15-1.02 B.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Construction Manager.

Unless otherwise specified, embedded anchor bolts shall be used instead of concrete inserts, wedge anchors, expansion anchors, adhesive, or other non-embedded type of anchor for expansion control installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during guide installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations. Anchors shall be directly connected to the pipe by welding or another acceptable, positive means.

Components in contact with plastic pipe shall be free of burrs and sharp edges.
Rollers shall roll freely without binding.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 40 27 05-1.01 A and 40 05 15.15-1.02 B shall inspect the completed expansion control system at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed expansion control

system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 15 requirements.

END OF SECTION

INDEX TO

SECTION 40 27 01.02

STEEL PIPE

SECTION 40 27 01.02

STEEL PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies steel pipe and fittings.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI B16.9	Factory–Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket–Welding and Threaded
ASTM A36/A36M	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot–Dipped, Zinc–Coated Welded and Seamless
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106 REV A	Seamless Carbon Steel Pipe for High–Temperature Service
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

Reference	Title
ASTM A283/A283M REV A	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot–Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM A572/A572M REV B	High Strength Low Alloy Columbium–Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger— Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services—Sizes 4 In. Through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold–Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile–Iron Water Mains and Their Appurtenances
AWWA M11	Steel Pipe—A Guide for Design and Installation
SSPC–SP10	Near–White Blast Cleaning

B. TESTING:

Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.

PART 2 – PRODUCTS

2.01 PIPE MATERIALS

Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 40 27 05, Piping Systems.

Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

2.02 PIPE MANUFACTURE

Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 40 27 05. The minimum wall thickness for ASTM A53 or ASTM A106 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

Connections shall be as specified in Section 40 27 05 and shall conform to Section 40 27 05.04. Coating for buried connections shall be as specified in paragraph 40 27 05.04–2.06.

2.04 FITTINGS AND APPURTENANCES

Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

Unless otherwise specified, steel fittings and appurtenances shall conform to the requirements of ASTM A234, ASTM A105, or ANSI B16.11; and fabricated steel fittings and appurtenances shall conform to AWWA C208.

Fittings for grooved end piping systems shall be full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings. Cast fittings shall be cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. Standard steel fittings, including large size elbows, shall be forged steel conforming to ASTM A106. Standard segmentally welded fittings shall be fabricated of Schedule 40 carbon steel pipe.

Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. CEMENT MORTAR:

Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2–inch by 4–inch by 13–gage self–furring wire mesh reinforcement for hand–applied lining.

C. HIGH TEMPERATURE SERVICE EPOXY:

Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC–SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

D. GLASS LINING:

Where specified, pipe and fittings shall be glass lined with a dual layer coating system of vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.

Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.

Glass lining shall be Ferrock MEH–32, Vitco SG–14, or equal.

2.06 PIPE COATING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be coated with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

The coating shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. POLYETHYLENE TAPE:

Where specified, pipe and fittings shall be coated and wrapped with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C214. The coating application shall be a continuous step operation in conformance with AWWA C214, Section 3. The total coating thickness shall be not less than 50 mils for pipe 24 inches and smaller and not less than 80 mils for pipe 26 inches and larger.

2.07 FUSION EPOXY COATING AND LINING

Where specified, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 203, or equal. Surface preparation shall be in accordance with SSPC–SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 12 mils minimum dry film thickness.

Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 306.

2.08 JOINT GASKETS

Joint gaskets shall be as specified in Section 40 27 05.02.

2.09 PRODUCT DATA

The following information shall be submitted for approval:

1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.

2. Contractor's layout drawings as specified in paragraph 40 27 05–2.04.

PART 3––EXECUTION

3.01 INSTALLATION

A. GENERAL:

Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 40 27 05.04.

Sleeve–type mechanical pipe couplings shall be provided in accordance with AWWA M11 and paragraph 40 27 05.04–2.02 A.

Pipe lining and coatings at field joints shall be applied as specified in paragraphs 40 27 01.02–2.05 and 2.06.

Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in paragraph 40 27 05.04–2.06.

B. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 TESTING

Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.03

PLASTIC PIPE

SECTION 40 27 01.03

PLASTIC PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies polyvinylchloride, chlorinated polyvinylchloride, polyethylene, and polypropylene pipe and fittings.

B. PIPE DESIGNATIONS:

For use in the Piping System Specification Sheets (PIPESPEC) in Section 40 27 05 and in this section, the following plastic pipe designations are defined:

Designation	Definition
PVC	Polyvinylchloride
CPVC	Chlorinated polyvinylchloride

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR–PR)
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket–Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657	Heat–Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket–Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket–Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

PART 2 – PRODUCTS

2.01 PVC PIPE

A. PRESSURE PIPE:

PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454–B. Pipe and fittings shall either be in accordance with ASTM D1785 or shall conform to ASTM D2241 for standard dimension ratios: 160 psi pipe—SDR 26; 200 psi pipe—SDR 21;

250 psi—SDR 17. Pressure rating for pipe shall be in excess of test pressure specified in Section 40 27 05. Neoprene gaskets with push–on joints shall conform to ASTM F477.

Schedule 80 PVC socket type fittings shall conform to ASTM D2467. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron or steel push–on IPS–sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 33 05 01.03 as applicable.

B. NONPRESSURE PIPE:

1. GRAVITY SEWER PIPE: PVC material for sewer pipe and fittings shall conform to Class 12454–B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 26. Neoprene gaskets with push–on joints shall conform to ASTM F477.

2. DRAIN, WASTE AND VENT PIPE: PVC material for drain waste and vent (DWV) pipe and fittings shall conform to Class 12454–B, ASTM D1784. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

2.02 CPVC PIPE

CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447–B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push–on joints shall conform to ASTM F477.

Schedule 80 CPVC socket type fittings shall conform to ASTM F439. Schedule 40 CPVC socket type fittings shall conform to ASTM F438. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

2.03 PRODUCT DATA

The following information shall be provided:

1. Manufacturer's certificates of compliance with the specified standards and Contractor's layout drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Solvent–cemented joints shall be made in

strict compliance with the manufacturer's/supplier's instructions and recommended procedures. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push–on joints and steel or ductile iron push–on or mechanical joint fittings. Fittings shall be lined and coated as specified in Section 33 05 01.03. Unless otherwise specified, PVC and CPVC piping exposed to sunlight shall be painted.

Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

Unless otherwise specified, PE pipe and fittings 4 inch diameter and smaller shall be joined by means of thermal socket fusion and pipe 6 inch and larger by thermal butt fusion. Butt–fusion joining of the pipes and fittings shall be performed with special joining equipment in accordance with procedures recommended by pipe manufacturer. Tensile strength at yield of butt–fusion joints shall not be less than pipe. Flanged adapters shall be provided for connection to valves and where specified.

3.02 TESTING

Testing of plastic piping shall be as specified in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.04

COPPER PIPING

SECTION 40 27 01.04

COPPER PIPING

PART 1–GENERAL

1.01 DESCRIPTION

This section specifies copper piping, tubing, couplings and fittings.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube

PART 2 – PRODUCTS

2.01 COPPER TUBING

Copper tubing shall be seamless copper, conforming to ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn, where used in exposed service and Type K, annealed or drawn for buried service.

2.02 COUPLINGS AND FITTINGS FOR COPPER TUBING

Unless otherwise specified, couplings and fittings for copper tubing 1/2 inch and smaller nominal diameter shall be compression type, brass or bronze, capable of holding the full bursting strength of the tubing; shall meet the requirements of ANSI B16.26; and shall be Swagelok, Gyrolok, or equal.

Couplings and fittings for copper tubing larger than 1/2–inch nominal diameter shall be wrought copper or bronze, solder joint pressure fittings and shall conform to ANSI B16.22.

2.03 SOLDER

Solder to be used in copper piping shall be ASTM B32, Alloy Grade Sn95 or Silvabrite 100.

2.04 PRODUCT DATA

Contractor's layout drawings and catalog data demonstrating compliance with this specification and giving full description of the copper piping shall be provided in accordance with contract submittal requirements.

PART 3 – EXECUTION

3.01 FABRICATION

A. SOLDER JOINTS:

All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints.

B. TAKEDOWN COUPLINGS:

Takedown couplings shall be screw union type and shall be provided in accordance with paragraph 40 27 05.04–3.03.

C. DIELECTRIC PROTECTION:

Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, the Contractor shall provide dielectric protection in accordance with Section 40 27 05.04– 3.05.

3.02 INSTALLATION, CLEANING, DISINFECTION, AND TESTING

The installation, cleaning, disinfection, and testing of copper piping shall be as specified in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.05

STAINLESS STEEL PIPING

SECTION 40 27 01.05

STAINLESS STEEL PIPING

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies stainless steel pipe and fittings.

B. TYPES OF SERVICE:

Stainless steel piping specified in this section shall be used for Aeration piping.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, 250, and 800
ANSI B16.11.80	Forged Steel Fittings, Socket Welding and Threaded.
ANSI B31.1	Power Piping
ANSI B36.19M	Stainless Steel Pipe
ASME Section IX (1989)	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications

Reference	Title
ASTM A182/A182M	Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/A194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A320/A320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products

B. QUALIFICATIONS:

All shop fabricated stainless steel pipe and fittings shall be furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be furnished. The pipe and fittings shall be shop-fabricated and field-installed in accordance with common industry wide practices and methods and shall comply with these specifications.

Only weld procedures which have been qualified under ASME Section IX and only welders who have successfully completed performance qualification tests per ASME Section IX on these qualified procedures shall be utilized.

C. TESTING:

Factory testing shall conform to the requirements of ASTM A312, ASTM A409 HT-0, or ASTM A778, depending on the size and type of stainless steel pipe provided.

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration*.

2. Shop fabrication drawings showing details of materials, piping, fittings, couplings, dielectric connections, joint locations and details, types and locations of supports.

3. Other data necessary to show conformance of the complete piping system to these specifications.

PART 2 – PRODUCTS

2.01 PIPE

Unless otherwise specified, stainless steel pipe 2-1/2 inches and smaller shall be Type 304L, seamless, threaded joints conforming to ASTM A312. The minimum wall thickness shall be Schedule 40S.

Unless otherwise specified, stainless steel piping 3 inches and larger shall be manufactured from ASTM A240 annealed and pickled sheets and plates, Type304L, in accordance with ASTM A778 or ASTM A409 HT-0. The minimum wall thickness shall be Schedule 5S. Only extra-low carbon (ELC) materials with 0.030 percent maximum carbon shall be used

2.02 FITTINGS

Unless otherwise specified, stainless steel fittings, 2-1/2-inches and smaller, shall be ASTM A403, of the same material and pressure rating as the pipe, threaded long radius with dimensions conforming to ANSI B16.11.

Unless otherwise specified, stainless steel fittings, 3-inch and larger, shall be butt-weld type manufactured in accordance with ASTM A774 of the same material and in the same thicknesses as the pipe. Reducers shall be straight tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated from pipe.

2.03 JOINTS

Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-weld joints or flanges. Unless otherwise specified, flanged joints shall be Van Stone joints made up of stainless steel slip-on type rolled-angle face rings and ductile iron backup flanges drilled to ANSI B16.1, Class 125 standard. The angle face ring thickness shall be equal to or greater than the wall of the pipe or fitting to which it is welded, and it shall be continuously welded on both sides to the pipe or fitting. The angle leg shall not interfere with the flange bolt holes. For submerged joints, backup flanges shall be stainless steel plate flanges. The backup flanges shall be supplied with the following nominal thicknesses.

Nominal pipe size, inches	Flange thickness, inches
3	1/2
4	9/16
6-10	5/8

2.04 COUPLINGS

A. GENERAL:

Fabricated stainless steel piping shall be shop-prepared for pipe couplings where specified. Unless otherwise specified, couplings shall be arched-band or grooved type.

B. SLEEVE TYPE:

Sleeve type couplings, where specified, shall be of standard steel construction as specified in paragraph 40 27 05.04-2.02 A. Pipe shall be plain-end with external weld beads ground smooth to ensure proper gasket seating. For pressure pipe lines, sleeve coupling joints shall be restrained by the use of harness rods connecting across the joint to flange lugs on adjacent flange joints. Where no adjacent flange joints exist, stainless steel harness lugs shall be welded to the pipe to receive the harness rods.

C. ARCHED-BAND TYPE:

Arched-band type couplings shall be stainless steel of the same material and wall thickness as the pipe and shall be Depend-O-Lok type as manufactured by Brico or equal. Couplings shall be Fixed--FxF, Expansion--ExE, or Fixed by Expansion--FxE as specified or as required. The pipe shall be plain-end with external weld beads ground smooth and with S.S. restraining rings shop-welded to the piping for fixed type couplings.

D. GROOVED-END TYPE:

Grooved-end or split type couplings shall be malleable iron or ductile iron as specified in paragraph 40 27 05.04-2.02 C except that submerged couplings shall be the same material as the pipe. The pipe ends shall be roll-grooved to the coupling manufacturer's specifications. Where roll grooving is impractical, the pipe shall have

heavy-wall machine-grooved pipe nipples or machined ring collars fully welded to the pipe or fitting. Nipples shall be taper-bored to the I.D. of the adjoining pipe to allow full-weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.

E. EXPANSION TYPE:

Unless otherwise specified, expansion couplings shall be the flanged rubber arch type as specified in Section 40 27 05.06. Pipe flanges shall be provided for these couplings.

2.05 THREADED CONNECTIONS

Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182 or ASTM A276, shop welded to the pipe at the locations specified.

2.06 GASKETS

Unless otherwise specified, gaskets shall be as specified in the PIPESPECS and in paragraph 40 27 05.04-2.03. For air lines, gaskets shall be neoprene or EPDM suitable for use at temperatures to 240 degrees F.

2.07 BOLTS

Bolts, nuts, and washers for stainless steel flange assemblies and stainless steel couplings shall be the same material, conforming to ASTM A320 for low-temperature service and ASTM A193 and ASTM A194 for high-temperature service. Bolts, nuts and washers for other couplings shall be as specified in referenced paragraphs for the couplings.

2.08 PIPE SUPPORT SYSTEMS

Unless otherwise specified, all hangers, rods, structural attachments, and other components of support systems for stainless steel pipe shall be of the same materials as the pipe and conform to Section 40 05 15.

2.09 FINISH

After all shop operations have been completed, pipe and fittings shall be pickled and passivated in manufacturer's plant, and scrubbed and washed until discoloration and possible iron picked up from manufacturing process are removed. The standard finish for 16-gage through 8-gage material shall be No. 1 or 2B per ASTM A480; 3/16-inch and heavier plate material shall be No. 1 mill finish or better per ASTM A480.

2.10 PRODUCT DATA

The following information and data shall be submitted for approval:

1. Certifications specified in the following documents:

   ASTM A403, paragraph 14.1
   ASTM A774, paragraph 14.1

ASTM A778, paragraph 14.1
ASTM A409, paragraph 17.1

2. Test results specified in paragraph 40 27 01.05-1.02 C.

3. Names and qualification records of proposed welders.

PART 3 – EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1. All pipe threads shall be lubricated with Teflon tape.

3.02 WELDING

A. GENERAL:

Piping with wall thickness up to 11 gage (0.120 inch) shall be welded with the TIG (GTAW) process. Unless otherwise specified, heavier walls shall be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler wire of ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inch on the I.D. and 3/32 inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert gas shielding shall be provided to the interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.

B. FIELD WELDING:

Field welding shall be minimized to the greatest extent possible by use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site, providing the but welds are performed only with an inert gas shielded process and that other applicable specified welding requirements are rigidly adhered to.

All residue, oxide, and heat stain is to be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Eutectic Company's "Eucleen," or equal, followed by complete removal of the agent.

C. PREPARATION OF SURFACES TO BE WELDED:

Surfaces of joints to be welded shall be free from mill scale, slag, grease, oil, paint, rust, and other foreign material. Joints to be welded shall be wire-brushed with stainless steel wire brushes and precisely fitted before welding.

D. WEATHER CONDITIONS:

Welding shall be done only when the surfaces are completely free of any moisture. Welding of the pipe shall not be done during periods of high winds or rain unless the areas being welded are properly shielded.

E. TACK WELDS, CLIPS, AND OTHER ATTACHMENTS:

Nicks, gouges, notches, and depressions in the base metal in the area of the joint shall be repaired before the joint weld is made. Tack welds, clips, and other attachments shall be removed and defects repaired, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Cracked tack welds shall be removed. Areas to be repaired shall be ground to clean metal and then repaired by building up with weld metal. The repaired areas shall be ground smooth to form a plane surface with the base metal.

F. DEFECTS AND REPAIRS:

Welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications shall be removed by chipping or grinding throughout their depth to clean base metal. Calking or peening of welds to correct defects shall not be done. Welds found deficient in dimension but not in quality shall be enlarged by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate. Weld deposits, slag, weld spatter, and projections into the interior of the pipe shall be removed by grinding.

3.03 MARKING, SHIPPING, AND STORAGE

All pipe, fittings, and fabrications shall be properly marked with type, gage, and heat number. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece-marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart. Pipe spools shall be loaded and blocked and lagged as necessary to ensure protection from damage during shipping. Stainless steel pipe and fittings shall be stored per manufacturer's recommendation. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.

3.04 FABRICATION/INSTALLATION REQUIREMENTS

The piping supplier during manufacturing, fabricating and handling stages, and the Contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be nonferrous or stainless steel or rubber-lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. All welded joints shall be treated with a pickling solution, brushed with stainless steel wire brushes and rinsed clean. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS, or equal, scrub with stainless steel brushes, and rinse clean.

3.05 COATINGS

After installation, the Contractor shall paint all steel or iron flanges, couplings, and appurtenances. Painting of the stainless steel pipe is not required. However, the Contractor shall be responsible for supplying and installing the stainless steel piping with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

END OF SECTION

INDEX TO

SECTION 40 27 05

PIPING SYSTEMS

SECTION 40 27 05

PIPING SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. General – This section specifies systems of process piping and general requirements for piping systems. Detailed specifications for the components listed on the Piping System Specification Sheets are found in other sections of Division 40 and 33. This section shall be used in conjunction with those sections.

   The majority of the valves are provided on this project by Ovivo as part of their equipment package. The valves listed in this specification are for valves that are not part of their package. The contractor shall coordinate with Ovivo to confirm the pipe connections to the valves supplied in their package.

   Contractor shall provide all piping and ancillary devices as shown, specified and required to provide a fully functional system.

2. Contractor Design of Piping Systems – In addition to materials, labor, and plant required to construct piping systems, Contractor shall provide professional engineering services (“Design Professional”) for the design and inspection of piping systems work.

   The Contractor shall provide the final design, inspection, and certification for the piping supports, seismic restraints, and provisions for control of dynamic forces and pipe expansion for buried and exposed piping on this project. Pipe supports are specified under Section 40 05 15. Seismic restraints are specified under Section 40 05 15.10. Pipe expansion control systems are specified under Section 40 05 15.15. The design of these systems shall be the product of a professional engineer currently licensed to practice in the State of South Carolina retained by the Contractor. The professional engineer (hereinafter and in all referenced sections the "Design Professional") shall obtain and maintain professional liability insurance in the amount of $1,000,000 aggregate to be in effect for duration of this project plus one year. The Design Professional shall have not less than five years experience in the type of piping support, seismic restraint and expansion control design work required for this project. This requirement, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work. Documentation demonstrating qualifications and insurance shall be submitted.

B. Definitions:

Pressure terms used in Section 40 27 05 and elsewhere in Division 40 are defined as follows:

1. Maximum: The greatest continuous pressure at which the piping system operates.

2. Test: The hydrostatic pressure used to determine system acceptance.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory–Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc–Coated Welded and Seamless

Reference	Title
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High–Temperature Service
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A536	Ductile Iron Castings
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR–PR)
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile–Iron Piping for Water and Other Liquids
AWWA C110	Ductile–Iron and Gray–Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber–Gasket Joints for Ductile–Iron and Gray–Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile–Iron and Gray–Iron Pipe with Threaded Flanges
AWWA C151	Ductile–Iron Pipe, Centrifugally Cast in Metal Molds or Sand–Lined Molds, for Water or Other Liquids
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger—Shop Applied
AWWA C206	Field Welding of Steel Water Pipe

Reference	Title
AWWA C207	Steel Pipe Flanges for Waterworks Services—Sizes 4 In. through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold–Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile–Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe—A Guide for Design and Installation
FEDSPEC L–C–530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL–H–13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL–STD–810C	Environmental Test Methods
UPC	Uniform Plumbing Code

B. Fittings and Coupling Compatibility – To assure uniformity and compatibility of piping components, fittings and couplings for grooved–end or shouldered–end piping systems shall be furnished by the same manufacturers.

C. Piping Supports, Seismic Restraints, and Expansion Control – Piping supports, seismic restraints, anchorage, and expansion control shall be designed by the Contractor's Design Professional selected under paragraph 40 27 05–1.01A. There may be situations where the Owner wants to control where certain anchors are located, the level of forces that can be transmitted to structures, the direction that expansion growth is allowed, or requires use of particular piping elements. In such cases these elements will be shown and shall be incorporated into the Design Professional's design.

Mandatory anchorage locations will be identified on the mechanical drawings, and maximum limitations, if any, for structure loads from the anchor will listed in kips, e.g. "X, 50", identifying location and 50,000 lb–force. Where structural load would be exceeded, piping flexibility or expansion joints shall be provided to achieve the maximum loading. If a particular type of support, anchor, seismic restraint or expansion element is detailed on the drawings, then those elements shall be incorporated into the Contractor's design. Piping submittals by the Contractor shall

include all elements, including those portions directed by the Owner, as well as complete piping runs. The structural reaction loads for all fixed supports shall be calculated and shown. The Contractor's Design Professional shall, as part of the submittal process, notify the Owner if he believes any Owner–shown elements are incompatible with the overall piping system and its function.

Additional requirements are specified in related sections.

D. Buried Piping – All buried piping shall be designed as fully–restrained systems. Where required, Design Professional shall size temporary and/or permanent thrust restraints. Restraint systems shall be designated to allow complete piping system disassembly without destructive measures.

Buried piping shall be provided as specified. Unless otherwise noted, materials specified in the PIPESPEC shall be used. Thicknesses specified in the PIPESPEC or referenced specifications shall be considered minimums. Excavation, installation and backfill shall be as specified.

Piping submittals by the Contractor shall include all elements, including those portions directed by the Owner, as well as complete piping runs. If a particular type of restraint or expansion element or approach is detailed on the drawings, then those elements shall be incorporated into the Contractor's design. The Contractor's Design Professional shall, as part of the submittal process, notify the Owner if he believes any Owner–shown elements are incompatible with the overall piping system and its function.

Additional requirements are specified in related sections.

1.03 SUBMITTALS

The following material shall be submitted for approval:

1. The qualifications of the Design Professional to be charged with design, inspection and certification of pipe supports, thrust and seismic restraints and pipe expansion control systems including education, proof of registration, proof of insurance, and previous experience in performing this type of work. The documentation shall be sufficient to demonstrate compliance with the requirements of paragraph 40 27 05–1.01 A. ***No further submittals under this or any related section will be considered until the qualifications of the Design Professional have been reviewed and accepted by the Construction Manager of Engineer of Record.***

2. A copy of this specification section, along with Sections 40 05 15, 40 05 15.10 and 40 05 15.15, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check–marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the

deviation. The Construction Manager and Engineer of Record shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. **Failure to include a copy of the marked–up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.**

PART 2 – PRODUCTS

2.01 PIPING MATERIALS

Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the piping system specification sheets. Piping materials shall conform to detailed specifications for each type of pipe and piping appurtenance specified in other sections of Division 40.

New and existing piping is designated by service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Contractor shall investigate and provide suitable connections, including electrical isolation, as necessary.

2.02 PIPING IDENTIFICATION

A. Plastic Coding Markers – Plastic markers for coding pipe shall conform to ANSI A13.1 and shall be as manufactured by W. H. Brady Company, Seton Name Plate Corporation, Marking Services Inc., or equal. Markers shall be the mechanically attached types that are easily removable; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe. Legend and backing shall be resistant to petroleum based oils and grease and shall meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL–STD–810C. Markers shall withstand a continuous operating temperature range of –40 degrees F to 180 degrees F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

Markers bearing the legends on the background colors specified in the PIPESPEC shall be provided in the following letter heights:

Outside Pipe Diameter,[a] Inches	Letter height, inches
Less than 1–1/2	1/2
1–1/2 through 3	1–1/8
Greater than 3	2–1/4

[a] Outside pipe diameter shall include insulation and jacketing.

In addition, pipe markers shall include uni– and bi–directional arrows, indicating flow direction, in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

B. Plastic Tracer Tape – Tracer tape shall be 6 inches wide, colored the same as the background colors as specified in Table A, paragraph 40 27 05–3.07, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

Two messages shall be printed on the tape. The first message shall read ***"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"*** with bold letters approximately two inches high. The blank shall be filled with the particular system fluid such as chlorine, oxygen or sulfur dioxide. The second message shall read *"**CALL**_____"* with letters approximately 3/4 inch high. Both messages shall be printed at maximum intervals of 2 feet.

C. Magnetic Tracer Tape – Polyethylene magnetic tracer tape shall be as manufactured by Allen Systems, W.H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal. Tape shall be acid and alkali–resistant, three inches wide, 0.005-inch thick, and have 1,500 psi strength and 140% elongation value. The tape shall be colored the same as the background colors as specified in paragraph 40 27 05–3.07 and shall be inscribed with the words "**CAUTION—PIPE BURIED BELOW**" and the name of the piping system.

2.03 VALVES

Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be non–asbestos material. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push–on and mechanical joints shall meet the requirements of AWWA C111. Valve operators are specified in Section 40 29 01.

2.04 PRODUCT DATA

Product data on piping materials and layout shall be submitted for approval:

A. Pre–Construction Data – All information specified shall be transmitted to the Engineer a minimum of four weeks prior to construction.

1. Design drawings and calculations for pipe supports, anchorage, seismic restraints, and expansion control systems as specified in Sections 40 05 15, 40 05 15.10, and 40 05 15.15. The drawings and calculations shall be sealed and submitted by the design professional specified in paragraph 40 27 05–1.02C through the Contractor. The Design Professional shall affirm that loads on structures are within the load limits noted on the contract documents.

2. Manufacturers' product literature on each bend, coupling, fitting, bolt, gasket, restraint or other item provided pursuant to this section.

3. A schedule showing the quantity provided and the piping system for each

item provided under this section.

4. Piping layout drawings, for both exposed and buried piping systems, depicting supports, locations of support, fittings and restraints, seismic restraint provisions, and other pertinent information, including wall and floor penetrations, where applicable. Submitted piping layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor and depicted on piping layout drawings. Drawings shall be original layouts by the Contractor; photocopies of contract drawings are not acceptable.

   Layout drawings and other Product Data shall be defined and depicted by system.

B. Post–Construction Data: - Inspection reports, authored, sealed and signed by the Design Professional retained under the provisions of paragraph 40 27 05–1.02 A. shall be submitted to the Construction Manager each week, as provided under paragraph 40 27 05–3.04. The Design Professional's final report shall be submitted to the Construction Manager and Engineer of Record before beneficial occupancy by the Owner, as provided under paragraph 40 27 05–3.04.

2.05 PIPE AND VALVE COMPATIBILITY

Selected pipe and pipe end connections for valves, or other equipment, shall be fully compatible within each piping system. Contractor shall coordinate the selection of pipe materials, linings and end connections so that valves operate properly over their entire range (e.g. sufficient disk clearance for butterfly valves). Selected end connections shall also be suitable for specified valve or equipment (e.g. wafer style valves or spectacle flanges shall be properly supported between flanges of equal inside diameter).

PART 3 – EXECUTION

3.01 INSTALLATION

A. Location – The Contract drawings are, in part, diagrammatic. Piping shall be provided as specified except for adjustments to avoid architectural and structural features and shall be coordinated with electrical construction. Adjustments to new piping shall be made to avoid interference and shown on the pipe layout drawings.

   Submitted piping layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

B. Piping Sizes – Where the size of piping is not specified, the Contractor shall provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than one inch in diameter) required for services not described by UPC shall be 1/2 inch.

C. Existing Piping Materials – Contractor shall pothole existing pipe at connections to new pipe to confirm material and joints prior to commencement of work.

D. Pipe Support, Anchorage, and Seismic Bracing:

1. General – Piping shall be supported by anchor brackets, guides, saddles or hangers. Pipe movement due to thermal expansion and internal pressure and dynamic forces shall be accommodated by pipe springing, anchors, expansion joints, and guides selected for the specific purpose by the design professional retained under the provisions of paragraph 40 27 05–1.01 A. The details for the piping support, anchorage, seismic bracing, and expansion control systems shall be submitted with the Contractor's piping layout drawings as product data under the provisions of paragraph 40 27 05–2.04.

   Acceptable types of supports, guides, saddles, expansion joints, flexible couplings, hangers and structure attachments for general piping support, expansion/contraction and for seismic bracing, as well as anchorage details, are referenced in Sections 40 05 15, 40 05 15.10 and 40 05 15.15 or shown on the drawings. Where a specific type of support or anchorage is indicated on the drawings, then only that type shall be used at that location.

   Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced as required to resist seismic loads. Supports shall be provided on each run at each change of direction. Piping supports manufactured of iron or steel shall be hot–dip or mechanically galvanized.

   Unless otherwise specified, existing pipes and supports shall not be used to support new piping. Existing tunnel pipe support racks can be used for new pipe if the Design Professional determines that the existing rack components are adequate to support the additional load.

2. Piping Connections to Machines – Piping at machine connections shall be aligned in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come–a–longs or other mechanical means to align field piping with the connections at the machines. Bolts shall not be forced into mating flange bolt holes and shall be capable being withdrawn using finger pressure alone. The use of ‘dutchmen’ mitered sections or similar specials to achieve the required alignment with machine connections is strictly prohibited.

E. Anchorage for Buried Piping – All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.

F. Bedding and Backfill – Bedding and backfill for buried piping shall be as specified and as shown on the drawings.

G. Equipment Connection Fittings - Equipment connection fittings, as specified in Section 40 27 05.04, shall be provided between field piping systems and equipment inlet and outlet connections.

H. Buried Pipe at Structures – Unless otherwise specified, buried piping shall have two flexible fittings or couplings where pipe passes through structures per Section 40 27 05.04 and as shown on the drawings. Restraints across each joint shall be provided.

3.02 PIPING IDENTIFICATION

A. Pipe Coding – After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with plastic markers as specified in paragraph 40 27 05–2.02 A. Legend markers and directional arrows shall be located at each side of walls, floors, and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50-foot centers.

B. Plastic Tracer Tape – A single line of tape as specified in paragraph 40 27 05–2.02 B shall be provided 2.5 feet above the centerline of buried systems 4, 5, and 7 pipe. For systems 4, 5, and 7, pipelines buried eight feet or greater below finished grade, Contractor shall provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

C. Magnetic Tracer Tape – Polyethylene magnetic tracer tape shall be buried 12 to 18 inches below ground and shall be above and parallel to buried nonferrous, plastic and reinforced thermosetting resin pipe lines. For pipelines buried eight feet or greater below final grade, the Contractor shall provide a second line of tape 2.5 feet above and parallel to the buried pipe.

3.03 VALVE IDENTIFICATION

Stainless steel tags bearing the specified valve number stamped in 1/4–inch high letters shall be installed on valve flanges in a position visible from floor level. Flangeless valves eight inches in diameter and larger shall have tags attached to the valve body by self–tapping corrosion resistant metal screws. Flangeless valves six inches in diameter and smaller shall have tags attached to the valve stem by stainless steel wire. Wire shall be 0.063 inch minimum.

3.04 INSPECTION

The Contractor shall cause the Design Professional retained under the provisions of paragraph 40 27 05–1.01 A to inspect the interior installation of the piping supports, anchorage, seismic restraints, and expansion control systems provided under this contract.

Upon completion of construction, but prior to beneficial occupancy of the piping systems by the Owner, the Design Professional shall conduct a detailed final inspection and furnish the Construction Manager with a final report in accordance with Section 40 05 15 requirements.

3.05 TESTING

A. General – Upon completion of piping, but prior to application of insulation on exposed piping, the Contractor shall test the piping systems. Pressures, media and

test durations shall be as specified in the PIPESPEC. Equipment which may be damaged by the specified test conditions shall be isolated. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Unless otherwise specified, the Contractor shall notify the Construction Manager 24 hours prior to each test.

Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

B. Gas, Air, and Vapor Systems: The Contractor shall test steam lines hydrostatically in accordance with the ASME procedure for testing pressure piping.

Testing medium and procedures for chlorine and sulfur dioxide systems are specified in paragraph 40 27 05–3.05 D.

Unless otherwise specified, the testing medium for other gas, air and vapor systems shall be as follows:

Pipeline Size	Specified Test Pressure	Testing Medium
2 inch and smaller	75 psi or less	Air or water
2 inch and smaller	Greater than 75 psi	Water
Greater than 2 inch	3 psi or less	Air or water
Greater than 2 inch	Greater than 3 psi	Water

The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include sulfur dioxide, chlorine, propane, sludge gas, and natural gas systems.

The allowable leakage rate for other systems tested with air shall be based on a maximum pressure drop of five percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure.

C. Liquid Systems – Leakage shall be zero at the specified test pressure throughout the specified duration for the following systems: exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. Testing procedures for chlorine and sulfur dioxide systems are specified in paragraph 40 27 05–3.05 D. Testing procedures for hydraulic and lube oil systems are specified in paragraph 40 27 05–3.05 E. Unless otherwise specified, leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping.

D. Hydraulic and Fluid Power Oil Systems – Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the

system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as product data (paragraph 40 27 05–2.04) that the ACL has been met.

E. Drains – Drain systems, other than pumped drain systems, shall be tested in accordance with UPC.

3.06 CLEANING AND FLUSHING

A. General – Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, and regulating or instrumentation equipment. The Contractor may, at his option, clean and test sections of buried or exposed piping systems. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. Temporary Screens – Upon completion of the cleaning, the Contractor shall connect the piping systems to related process equipment. Temporary screens, provided with locator tabs which remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment suction or piping size, inches	Maximum screen opening, inches
0 –1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

The Contractor shall maintain the screens during testing, initial start–up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for performance tests. The Contractor shall remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Liquid systems handling solids shall have screens in place for clear water testing and operation. Initial operation on solids following clear water testing may be without screens.

C. Gas and Air Systems – Unless otherwise specified, gas and air system piping six inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than six inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon completion of cleaning, the piping shall be drained and dried with an airstream. Sludge gas, natural gas and propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psi until

put in service. Chlorine and sulfur dioxide systems shall be cleaned in accordance with paragraph 40 27 05–3.06 E.

D. Liquid Systems – After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water. With temporary screens in place, the liquid shall be circulated through the piping system using connected equipment for a minimum period of 15 minutes and until no debris is collected on the screens. Liquid chlorine and sulfur dioxide lines shall be cleaned in accordance with paragraph 40 27 05–3.06 E.

Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as product data (paragraph 40 27 05–2.04) that the ACL has been met.

E. Potable Water Systems – Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.

3.07 PIPING SPECIFICATION SHEETS (PIPESPEC)

Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets (PIPESPECS). Piping services are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of services (PIPESPEC) is identified by a piping system number. Piping services specified in the PIPESPECS and on the drawings are alphabetically arranged by designated service symbols as shown in Table A. Table A also indicates the piping material system number, fluid category, and pipe marker background color of each service.

Table A: Process Piping Services

Pipe Designation	Pipe Service	Material	Interior Lining	Test Pressure, Psi
2W	Nonpotable City Water	ST	–	200
3W	Service Water (Filtered Effluent)	ST	–	200
CA	Compressed Air	SS	–	20
DR / TD	Drain	DI	CL	125
DSF	Diesel Fuel	ST	–	150
FE	Final Effluent	DI	CL	125
NaOH	Sodium Hydroxide	PVC	–	150
PA	Process Air	SS	–	20
PRMT (inside)	Permeate	PVC	–	125
RAS	Return Activated Sludge	ST /DI	EP	125
RS	Raw Sewage	ST /DI	EP	125
SHC	Sodium Hypochlorite	PVC*	–	150
SL	Sludge	DI	EP	100

WAS	Waste Activated Sludge	ST /DI	EP	125

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service CA—Compressed Air
PA – Process Air

Test Requirements:

Medium: Air; ref. spec paragraph 40 27 05–3.04 B.
Pressure: 20 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Mech Cpl: EPDM

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Stainless steel; ASTM A312, Schedule 40S. Ref. spec Section 40 27 01.05.
Conn; threaded, ANSI B1.20.1.
Ftgs; ASTM A403, material, ends and wall thickness to match pipe.

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Lift check; Crane 27TFE, Lunkenheimer 231, or equal.

(3" and larger)

Pipe: Stainless steel; ASTM A778. Ref. spec Section 40 27 01.05.
Conn; butt weld or flanged, couplings where specified.
Ftgs; ASTM A774, material, ends and wall thickness to match pipe.

Valves: Butterfly; ref. spec. Section 40 29 13. Line with 10 mils of epoxy per spec Section 40 27 01.02.

Remarks:

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: FE—Final Effluent

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 60 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller)

Pipe: Steel; ASTM A53, galvanized. Ref. spec Section 40 27 01.02.
Conn; taper threaded, ANSI B1.20.1. Flanged adapters for 2–1/2 inch, 3 inch valves.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

(2" and smaller)

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Swing check; Crane 137, Lunkenheimer 230, or equal.

(4" thru 8")

Pipe: Steel; ASTM A53, ERW, Grade B, black, with cement mortar lining. Ref. spec Section 40 27 01.02.
Conn; grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel, per spec Section 40 27 01.02; ends and lining to match pipe.

Or

Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

(2 1/2" thru 8")

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.
Swing check; spring loaded per spec Section 40 29 27.

(10" thru 24")

Pipe: Steel; same as 8 inch or AWWA C200, 3/16 inch thick, with cement mortar lining. Ref. spec Section 40 27 01.02.
Conn; same as 8 inch. See Remarks.
Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208. Lining and ends to match pipe.

Valves: Butterfly; ref. spec Section 40 29 13.
Check; per spec Section 40 29 27.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, NSF certified, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.

(4" to 12")

Pipe: Ductile iron; AWWA C151 with cement mortar lining. Ref. spec Section 33 05 01.03.
Conn; grooved end or restrained push–on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile iron per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: 2W—No. 2 Water (nonpotable City Water)
3W—No. 3 Water (Filtered / Chlorinated Effluent)

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 200 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A53, galvanized. Ref. spec Section 40 27 01.02.
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Swing check; Crane 137, Lunkenheimer 230, or equal.

(2 1/2" thru 8")

Pipe: Steel; ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 40 27 01.02.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel per spec Section 40 27 01.02; ends to match pipe.

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.
Check; per spec Section 40 29 27.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Gate; ref. spec Section 15101, with extension stem and valve box. Coating.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; grooved end or restrained push–on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile iron per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating.

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 40 27 05.08–3.03.

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: TD–Tank Drain

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2 1/2" thru 4")

Pipe: Steel; ASTM A53 ERW, Grade B, black, no lining. Ref. spec Section 40 27 01.02.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel per spec Section 40 27 01.02; ends to match pipe.

Valves: Mud Valves; per spec Section 40 29 50.

(6" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Mud Valves; per spec Section 40 29 50.

Buried and Encased Pipe:
(See drawings for pipe size. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: RAS—Return Activated Sludge
WAS—Waste Activated Sludge
RS– Raw SewageTest Requirements:
Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 120 minutes

Gasket Requirements:
Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller)
Pipe: Steel; ASTM A53, galvanized. .
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSIB16.3, Class 150, galvanized.

Valves: Eccentric plug; per spec Section 40 29 19. Install valve with seat upstream.
Swing check; Lunkenheimer 230, Crane 137, or equal.

(4" thru 12")
Pipe: Ductile iron; AWWA C151. Epoxy Lined Ref. spec Section 33 05 01.03.
Conn; flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; ends to match pipe.

Valves: Eccentric plug; per spec Section 40 29 19. Install valve with seat upstream.
Check; per spec Section 40 29 27.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: SL—Sludge

Test Requirements:
Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 100 psig
Duration: 120 minutes

Gasket Requirements:
Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder

Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; flanged or mechanical.
Ftgs; ductile iron, per spec Section 33 05 01.03; ends to match pipe.

Valves: Eccentric plug; per spec Section 40 29 019. Install valve with seat upstream.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: DSF—Diesel Fuel

Test Requirements:

Medium: Fuel oil; ref. spec paragraph 40 27 05–3.04 E.
Pressure: 150 psig (pressure piping)
5 psig (nonpressure piping)
Duration: 60 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–On/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A106, seamless, Grade B, black, pickled. Ref. spec Section 40 27 01.02.
Conn; threaded or socket weld with threaded adapters for valves.
Ftgs; forged steel, ASTM A105, ANSI B16.11, pressure Class 3000, pickled.

Valves: Lubricated plug; cast iron, PTFE coated plug, Nordstrom Fig. 142, Walworth Fig. 1796, or equal.
Lift check; Crane 27TF, Lunkenheimer 231, or equal.

(2 1/2" thru 12")

Pipe: Steel; ASTM A53, seamless, Grade B, black, pickled. Ref. spec Section 40 27 01.02.
Conn; butt weld, flanged for valves.
Ftgs; steel, ASTM A234, seamless, ANSI B16.9, pickled; ends shall match pipe.

Valves: Lubricated plug; cast iron with PTFE or molydisulfide coated plug, Nordstrom Fig. 143, Walworth Fig. 1797F, or equal, thru 5 inch; worm gear operator Rockwell Fig. 149, Walworth Fig. 1727F, or equal, 6 to 12 inches.

Swing check; cast iron, flanged, Jenkins 1025–B2, Walworth 5344F, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type.)

(2" and larger)

Pipe: Reinforced thermosetting resin (RTRP); Type 1, ref. spec Section 15058. Double containment unless otherwise specified. Provide magnetic tracer tape.
Conn; bonded bell and spigot or flanged.
Ftgs; RTRP to match pipe, ref. spec Section 15058.

Valves: Lubricated plug; same as exposed with extension stem and valve box.

Remarks:

1. The cleaning (pickling) solution used shall comply with Mil–H–13528B. Immediately following pickling and rinsing procedures, steel pipe and fittings shall be coated inside and outside with a rust and corrosion preventative system, and the ends sealed to prevent the entry of dirt.

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: PRMT – Permeate
NaOH–Caustic Soda
SHC—Sodium Hypochlorite (See Remark 1)

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 150 psig
Duration: 120 minutes

Gasket Requirements:

Flange: PTFE bonded EPDM, full–face gaskets, ANSI B16.1.
Push–on/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Pipe and fittings exposed to sunlight shall be painted. Ref. spec Section 15064.
Conn; plain end, solvent weld, flanged for valves 3 inch and larger.
Ftgs; PVC, Sch. 80, solvent weld.

(4" and less)

Valves: Ball; PVC Chemtrol Tru Bloc TU Series, Asahi/America Duo Bloc TU Series, GSR TU Series, or equal, with PTFE seats and EPDM 0–rings.
Diaphragm; PVC body, Chemtrol Series PD, Posacon 677, Asahi/America, or equal with EPDM or PTFE diaphragm.
Ball check; PVC body, Chemtrol Series BC, Asahi/America, or equal with EPDM or PTFE seats/seals.

(5" and larger)

Valves: Diaphragm; ITT Dia–Flo 2558–2–M, Hills–McCanna 0649–1–38, or equal.
Swing or ball check; fully lined valve body; fully coated swing check flapper or ball check ball; lining and coating shall be Hypalon or fluorinated ethylene propylene. Valve and Primer Co. APCO Series 100R, Peabody Dore Model 770, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe: PVC; same as exposed. Provide magnetic tracer tape.
Conn; same as exposed.
Ftgs; same as exposed.

(2" and less)

Valves: Ball; same as exposed with extension stem and valve box.

(2 1/2" and larger)

Valves: Diaphragm; same as exposed with extension stem and valve box.

Remarks:

1. For HOCL service, the following shall apply:

a. Ball valves are not permitted on HOCL service.

b. Diaphragm valves 4 inches and smaller shall be provided with PTFE diaphragms; valves 5 inches and

larger shall be provided with Hypalon or PDVF linings with PTFE diaphragms.

c. Sodium hypochlorite solvent weld shall be with adhesives developed specifically for NaOCL service.

2. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 40 27 05.08–3.03.

END OF SECTION

INDEX TO

SECTION 40 27 05.02

JOINT GASKETS

SECTION 40 27 05.02

JOINT GASKETS

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies rubber gaskets for push-on compression type joints used with fabricated steel pipe, steel pipe, reinforced concrete pipe, concrete cylinder pipe, and cement mortar lined and coated steel pipe.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D395	Rubber Property--Compression Set, Test for
ASTM D412	Rubber Properties in Tension, Test for
ASTM D471	Rubber Property--Effect of Liquids, Test for
ASTM D573	Rubber--Deterioration in an Air Oven, Test for
ASTM D1149	Rubber Deterioration--Surface Ozone Cracking in a Chamber (Flat Specimens), Test for
ASTM D2240	Rubber Property--Durometer Hardness, Test for

B. Testing - Certified copies of test reports indicating that the gasket material has been tested and that the results of the tests comply with the requirements specified in paragraph 40 27 05.02-2.02 shall be provided as product data.

PART 2 – PRODUCTS

2.01 MATERIALS

Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain no less than 50% by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.

2.02 PHYSICAL REQUIREMENTS

The compound shall meet the following physical requirements when tested in accordance with the specified ASTM standards.

A. Tensile (ASTM D412) – The tensile strength shall be 1,500 psi minimum and the ultimate elongation shall be 350 percent minimum.

B. Hardness (ASTM D2240, Type A Durometer) – The compound shall have a hardness in the range of 35 to 50 for concrete spigots and 50 to 65 for steel spigots.

C. Compression Set (ASTM D395) – The compression set shall not exceed 20% when compressed for 22 hours at 70 degrees C.

The test specimens shall be circular discs cut from the gaskets. Test specimens shall be 0.500 ($\pm$ 0.005 - 0.025) inches in height. The diameter of the test specimen shall be that of the gasket but not to exceed 1.129 $\pm$ 0.010 inches in diameter.

D. Aging (ASTM D573) – The test specimen deterioration shall be less than 20 percent reduction in tensile strength, 40 percent reduction in ultimate elongation, and 15 points increase in hardness.

E. Effect of Liquids (ASTM D471): The maximum volume change in oil and in water shall be as follows:

1. Oil: 100% in ASTM oil No. 3.

2. Water: 15%.

The test specimens shall have a thickness of 0.080 $\pm$0.005 inches and shall be circular discs cut from the gasket.

F. Ozone Cracking (ASTM D1149) – The test specimen shall be a gasket loop mounted to give at least 20% elongation. There shall be no cracking visible at two times magnification of the gasket after 100 hours exposure to 1 mg/l ozone at 40 ºC.

2.03 PRODUCT DATA

Provide certified copies of test reports specified in paragraph 40 27 05.02-1.02 B.

PART 3 – EXECUTION

The gaskets shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 27 05.04

PIPING CONNECTIONS

SECTION 40 27 05.04

PIPING CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME Bl.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI Bl.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials

Reference	Title
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

1.03 SUBMITTALS

Provide catalog data demonstrating compliance with this specification and giving full description of the piping connections shall be provided in accordance with contract submittal requirements.

PART 2 – PRODUCTS

2.01 FLANGE ASSEMBLIES

A. Flanges:

1. General – Flanges shall either be flat flanges or convoluted ring flanges as specified in the following paragraphs.

2. Flat Flanges – Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain faced flanges shall not be bolted to raised face flanges.

3. Convoluted Ring Flanges – Convoluted ring flanges shall be ductile iron, forged steel or cast stainless steel, designed to bear on hubs welded to the pipe and shall be as manufactured by Improved Piping Products. The Construction Manager knows of no equal. The flange joints shall be rated for not less than 150% of the test pressures listed in Section 40 27 05 and shall conform to the requirements of ANSI B 16.5 and AWWA C207. The flange manufacturer shall be prepared to demonstrate, by certified pressure test that the flanges will meet these requirements.

B. Gaskets:

1. Gasket material shall be as specified in paragraph 40 27 05.04-2.03.

2. Gaskets for plain faced flanges shall be the full face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter, and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16 inch thick for pipe 3-1/2 inches and less in diameter and 1/8 inch thick for pipe 4 inches and larger.

C. Bolts:

1. Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI Bl.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.

2. Unless otherwise specified, bolts shall be carbon steel machined bolts with hot pressed hexagon nuts. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

2.02 MECHANICAL COUPLINGS

A. Sleeve-Type Couplings:

1. Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal.

2. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, markingF593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04, or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C111.

B. Plain End Couplings:

1. Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.

2. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C606.

C. Grooved End Couplings:

1. Grooved end flexible-type couplings shall be Gustin-Bacon 100, Victaulic Style 77, or equal. Grooved end rigid-type couplings shall be Gustin-Bacon 120 Rigi-Grip, Victaulic Style 07 Zero-Flex, or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter; for pipe 12 inches in diameter and less in rack-mounted tunnel piping applications; and for grooved joints adjacent to pump or blower suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved end flanged coupling adapters shall be either Gustin-Bacon 154, Victaulic Style 741, or equal. Snap-joint grooved end couplings shall be Gustin-Bacon 115, Victaulic Style 78, or equal. Cut grooves are not permitted on fabricated or lightwall pipe.

2. Unless otherwise specified, bolts and nuts shall comply with AWWA C606. Bolts for submerged service shall be Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C 606.

D. Dismantling Joints – Dismantling joints may be used as takedown couplings in accordance with paragraph 40 27 05.04-3.03. Dismantling joints shall fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts. Design of equipment connection fittings shall conform to AWWA C219. 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. Dismantling joints shall be Romac DJ-400, Smith Blair 975, or Crane-Viking Johnson Dismantling Joint.

E. Sleeve Band Couplings – Sleeve band couplings shall be Victaulic Depend-O-Lock. Unless otherwise noted, couplings for liquid service shall be Model F x F Type 2 fully restrained, shouldered high deflection couplings with standard width band. Couplings shall comply with AWWA C-219. Couplings for use with air systems shall be Airmaster restrained Depend-O-Lock couplings in conformance with AWWA C-606. Sleeve band couplings are acceptable wherever sleeve type couplings are used (paragraph 40 27 05.04-2.02 A.)

2.03 GASKETS

Gaskets designated in Section 40 27 05 shall be as follows:

A. EPDM: ethylene-propylene-diene-terpolymer.

B. Neoprene: neoprene.

C. Nitrile: nitrile (Buna N).

D. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).

E. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).

F. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).

G. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).

H. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).

I. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.

J. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.

2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI Bl.20.1.

2.05 DIELECTRIC UNIONS

Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

2.06 COATINGS

Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated.

2.07 PRODUCT DATA

The Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

PART 3 – EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1.

3.02 PIPE WELDING

A. Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 40 27 05. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 40 27 05.

B. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.03 TAKEDOWN COUPLINGS

A. Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within three feet of the wall, unless specified otherwise.

B. A union or flanged connection shall be provided within two feet of each threaded end valve.

3.04 FLEXIBILITY

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single Flexijoint) as specified on the buried pipe within two feet of the structure for 2-inch through 6-inch diameter pipe; within three feet of the structure for 8-inch through 24-inch diameter pipe; and within 1.5 pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

3.05 DIELECTRIC CONNECTIONS

Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 40 27 05.04-2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

END OF SECTION

INDEX TO

SECTION 40 27 05.06

EXPANSION JOINTS

SECTION 40 27 05.06

EXPANSION JOINTS

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies piping expansion joints.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 5

B. Selection Criteria – The selection and installation of expansion joints shall be in conformance with the expansion control system designed by the Design Professional, retained under the requirements of paragraph 40 27 05–1.01 A, and the criteria specified herein. This requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. Design Criteria:

1. General – Expansion joints shall be designed in accordance with EJMA Standards for pressure, temperature and service as specified in the Piping System Specification Sheets (PIPESPEC) without crimping of corrugations.

2. Expansion Joints – Corrugated type expansion joints shall be suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).

1.03 SUBMITTALS

The following submittals shall be submitted for approval:

A. Design and construction details of formed metal bellows type expansion joints.

B. Pressure thrust force and spring rate data for formed metal bellows expansion joints.

C. Details for installation of all expansion joints.

D. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.

PART 2 – PRODUCTS

2.01 EXPANSION JOINTS

A. Metal Construction:

1. Formed Bellows Type:

a. Formed bellows type expansion joints for temperatures up to 800 ºF shall have 300 series stainless steel multi–ply bellows rated for the specified design temperature and pressure. Test pressures are specified in Section 40 27 05. Each expansion joint shall be factory tested at the test pressure. Ductwork expansion joints may be rated at less than 50 psig but must be rated equal to the design pressure and, in no case, less than 2 psig.

b. Expansion joint design shall be determined by the amount and kind of movement specified (axial, lateral, angular). Unless otherwise specified, end connections shall be flanged. Formed bellows type expansion joints shall be as manufactured by Flexonics, Inc., Hyspan Precision Products, Inc., American BOA Inc. or equal.

2. Steel Expansion Compensator Type – Steel expansion compensator type expansion joints shall be Flexonics Model H Expansion Compensator, Hyspan Series 8500, Keflex 7Q, or equal. Compensators shall have 2–ply stainless steel bellows and carbon steel shroud and end fittings. Compensators shall be rated for 175 psi maximum working pressure and 750 degrees F.

3. Bronze Expansion Compensator Type – Bronze expansion compensator type expansion joints shall be Flexonics Model HB Expansion Compensator,

Hyspan Series 8500, Keflex 7Q, American BOA Inc., or equal. Compensators shall have multi–ply phosphor bronze or stainless steel bellows and copper tube end fittings. Compensators shall be rated for 150 psi maximum working pressure and 400 ºF.

B. Elastomer and Fabric Construction:

1. General:

a. Elastomer and fabric expansion joints shall be the standard spool arch type or the precision molded spherical design type as indicated or specified. Expansion joint connectors shall have control units (restraints) to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Number and sizes of control rods or restraints shall be as determined by the manufacturer. Unless otherwise specified, single arch and sphere type expansion joints shall have 6–inch face–to–face dimension for pipe up to eight inches and 8–inch face–to–face dimension for pipe 10 and 12 inches.

b. The cover elastomer shall be chlorobutyl, neoprene or EPDM. For temperatures between 180 and 240 ºF, the tube elastomer shall be chlorobutyl or EPDM. Neoprene or Buna N liners are acceptable for temperatures to 180 ºF.

c. Elastomer and fabric type expansion joints used for exterior service shall have ultra–violet light protection.

d. Elastomer and fabric type expansion joints shall not be used for pump discharge piping and where surge forces may be expected.

2. Spool Type:

a. Spool type expansion joints shall be of the resilient arch type and shall be standard or tapered as specified. Unless otherwise specified, all tapered connectors shall be eccentric.

b. Spool type expansion joints shall be constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body. Standard arch type expansion joints suitable for the specified temperature and pressure shall be provided with retaining rings or backup rings. Retaining rings shall be 3/8–inch thick steel, split, either galvanized or zinc shield coated. Expansion joints, single, multiple, or filled arch, shall be Mason Style EJBN, Garlock Style 204, Mercer Style 500, Goodall Style E–1462, General Style 1025, or equal.

c. Filled arch type shall be used on all piping systems carrying fluids containing solids. High pressure couplings suitable for 240 ºF operating temperatures shall be Mason Style EJBN–HD, Mercer Style 510, Garlock Style 204–HP, Goodall Style E–1489, General Style 1015, or equal.

3. Spherical Molded Type – Spherical molded type expansion joints shall be precision molded of multiple plys of nylon tire cord fabric and elastomer suitable for specified temperature and pressure. Spherical molded type expansion joints shall have steel or ductile iron floating flanges, and no metal parts shall come in contact with the fluid. Single sphere molded connectors shall be Mason Type MFNC, Mercer Type 5500, Goodall Type E–611, General Type 1010, Garlock Style 8100, or equal. Double sphere or triple sphere connectors shall be provided where required to provide for the specified movement.

C. Polyvinylchloride Construction - Polyvinylchloride expansion joints shall be Celanese "Chemtrol" CPVC slip type with Teflon impregnated seal rings, Certain–teed Fluid Tite PVC, Johns–Manville PVC double bell expansion joint, or equal.

D. Teflon Construction – Teflon expansion joints shall be molded TFE bellows and shall be Metraflex T–2, Garlock Style 215, Resistoflex R–6905, EGC Style M–150, or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Expansion joints and anchors shall be located as specified. Location and number of guides shall be determined from EJMA Standards.

B. Expansion joints shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.

C. Unless otherwise specified, expansion joints four inches and larger shall be furnished with control rods.

3.02 ALIGNMENT

Piping systems shall be aligned prior to installation of expansion joints. Expansion joints shall not be used to correct piping misalignment during installations. Expansion joints normally preset at the factory for rated axial compression and expansion shall be installed in this preset condition.

3.03 EXPANSION JOINT AND CONNECTOR SCHEDULE

Expansion joints provided for specific equipment items or piping systems are specified on the following schedule. The location of piping system expansion joints and design criteria, including temperature, pressure and movement for each joint, are specified and/or shown on the drawings.

Expansion Joint and Connector Schedule

Type of Expansion Joint/Connector	Type of Service/Use
Formed metal bellows; medium temperature (2.01 A.1.a.)	Boiler exhaust, hot water, high pressure air, and gas and steel lines subjected to ambient temperature differentials sufficient to require expansion joints.
Steel expansion compensator (2.01 A.2.)	Same type service/use as for "formed metal bellows type expansion joint" except size of piping is limited to 3-inch diameter or less.
Bronze expansion compensator (2.01 A.3.)	Copper piping.
Elastomer spool arch (2.01 B.2.)	Blower connectors and expansion joints for piping 14-inch diameter and larger.
Elastomer spherical molded (2.01 B.3.)	Blower connectors and expansion joints for piping 12-inch diameter and less.
PVC (2.01 C.)	PVC piping.
Teflon (2.01 D.)	RTRP (FRP) piping.
Teflon flexible connector (2.03)	Connection of PVC piping to chemical storage tanks.

[a] Excludes steam and chemical services.

END OF SECTION

INDEX TO

SECTION 40 27 05.08

PIPING APPURTENANCES

SECTION 40 27 05.08

PIPING APPURTENANCES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE

1. This section specifies pipeline thermometers, flow and level gages, pressure gages, strainers, steam traps, vents, and drains.

B. EXCLUSIONS:

1. Temperature, pressure and flow measuring devices used for instrumentation are specified in Other Sections.

PART 2 – PRODUCTS

2.01 PIPELINE THERMOMETERS

A. GENERAL:

1. Pipeline thermometers shall be suitable for the 50 – 150 degrees Fahrenheit. Pipeline thermometers shall indicate fluid temperatures within the pipeline to an accuracy of plus or minus two percent of thermometer full scale.

2. Pipeline thermometers shall be provided with threaded thermowell mountings, designed to permit removal of the thermometer without depressurization or loss of process fluid. For insulated pipes a thermowell with a lagging extension shall be provided.

B. BIMETALLIC THERMOMETERS:

1. Unless otherwise specified, bimetallic type thermometers shall be of the adjustable angle type mounted for convenient viewing. Bimetallic thermometers shall have type 304 stainless steel case. Thermometer dials shall be a minimum of five inches in diameter and shall be equipped with an external adjustment mechanism for zero reset. Bimetallic thermometers shall be Ashcroft Type EH, Marsh Mastertherm, or equal.

C. FILLED THERMOMETERS:

Unless otherwise specified, filled type thermometers shall have minimum scale length of nine inches and shall be of the adjustable angle type mounted for convenient viewing. Filled thermometers shall consist of a type 304 stainless steel frame and a mercury-filled pyrex tube. The thermometer tube shall be recessed into the frame. Filled thermometers shall be Weksler, Taylor, or equal.

2.02 FLOW AND LEVEL GAGES

A. ROTAMETERS:

1. Unless otherwise specified, rotameters for purges and other low capacity services shall be Brooks Sho-Rate "50," Wallace & Tiernan three-inch purge meter, Schutte & Koerting, or equal, with integral needle valve and flow controller. Meter tubes shall be glass, floats shall be stainless steel, and cases shall be aluminum or stainless steel. Unless otherwise specified, meter sizes shall be selected so that the flow rate recommended by the manufacturer of the purged equipment falls within the middle third of the meter scale. Units shall have a 3-inch minimum scale direct reading in the units of flow.

2. Rotameters for high capacity service shall be glass tube-type with a 5-inch scale and stainless steel frame. Flow range shall be as specified and scales shall indicate the units of flow. Rotameters shall be as manufactured by Brooks, Wallace & Tiernan, Schutte & Koerting, or equal.

B. SIGHT GAGES:

1. Sight gages shall be 3/4-inch Penberthy 205 Series, Lunkenheimer Fig. 589, or equal, automatic water gage complete with pyrex gage glass and gage glass protector. Overall length of gages, type of mounting, and orientation of set shall be as specified.

C. FLOW INDICATORS:

1. Flow indicators shall be provided where specified. Each indicator shall consist of a bronze body with threaded ends and a sight glass with rotary wheel. Pressure ratings for flow indicators shall match pipe pressure ratings. Indicators shall be as manufactured by Jacoby-Tarbox, Schutte & Koerting, Eugene Ernst Products, or equal.

2.03 PRESSURE DEVICES

A. GAGE COCKS:

1. Unless otherwise specified, gage cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gage cock shall be protected by a brass plug.

B. PRESSURE GAGES:

1. Unless otherwise specified, pressure gage scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale, shall be 4 1/2-inch, 270-degree movement, 1/2-percent accuracy, full-scale, and suitable for bottom stem mounting. Gages shall have a 316-SS bourdon tube. All gages shall have a 300 series stainless steel case, shatterproof glass, and a 1/2-inch NPT bottom connection.

2. Pressure gages for air, gas, and low pressure services (0-10 feet) shall be premium grade, heavy-duty bourdon-tube units (bellow type for vacuum) with Delrin bushings and pinion, and stainless steel sector.

3. Gages on liquid service shall be as noted above, except they shall be provided with an internal pulsation dampening system consisting of either a glycerin fill or a silicone fluid fill. Snubbers or orifices shall not be utilized. Gages shall be Ashcroft Duragauge Fig. 1279, Ametek 1981L, or equal.

C. DIAPHRAGM SEALS:

1. Unless otherwise specified, seals shall be diaphragm type with 1/4-inch flushing connection, Type 316 stainless steel body and Type 316L diaphragm. Fill fluid shall be Silicone DC200 unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

D. PRESSURE SENSORS

1. Unless otherwise specified, pressure sensors (tubular chemical seals) shall be the in-line full stream captive sensing liquid type. Wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated for 200 psi with five-inch SC hysteresis. Seals shall be Ronningen-Petter, Red Valve, or equal.

2. Fill fluid shall be rated for a temperature range of -20 degrees Fahrenheit to 200 degrees Fahrenheit. Capillary tubing shall be armored stainless steel. Fittings shall be provided for vacuum filling of system. Systems that are not factory filled shall be vacuum filled in the field. Filling connections shall be soldered shut after vacuum evacuation and filling.

2.04 STRAINERS

A. AIR AND GAS STRAINERS:

1. Unless otherwise specified, air and gas line strainers shall be Y-pattern, cast iron body, with 40 mesh Monel screens packed with Everdur wool. Bronze bodies shall be provided with copper piping. Air line strainers shall be fitted with a brass blow off cock. Strainers shall be Mueller, Armstrong, or equal.

B. STEAM AND WATER STRAINERS:

1. Steam and water strainers shall be of Y-pattern, unless otherwise specified. Steam strainers shall have carbon steel body; water strainers shall have cast iron body. Bronze bodies shall be provided with copper piping. Strainers shall have 304 stainless steel screens and tapped and plugged blow off connections. Screen perforations shall be 0.020 inch for steam service and 0.045 inch for water service. Strainers shall be Mueller, Armstrong, or equal.

C. FUEL OIL STRAINERS:

1. Fuel oil strainers shall be of the basket type and shall have cast iron body with 304 stainless steel screens. Screen perforation shall be 3/64 inch. Strainers shall be Bailey No. 1, Mueller, or equal.

2.05 PRODUCT DATA

A. Manufacturer's product data shall submitted for approval.

PART 3 – EXECUTION

3.01 PIPELINE THERMOMETERS

A. Unless otherwise specified, filled thermometers shall be used on all water based services, and bimetallic thermometers shall be used for high temperature (300 degrees F or above) steam or gaseous services. Filled thermometers shall be installed where vibration or unstable mounting conditions exist. Thermometers shall be provided for all water and process stream inlets and outlets at each heat exchanger, heat extractor, and chiller; where shown, and adjacent to process taps for temperature sensing or transmitting instrumentation.

3.02 GAGE TAPS

A. Gage taps shall be provided on the suction and discharge of all pumps, fans, compressors, vacuum pumps and blowers. Gage taps shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

3.03 VENTS AND DRAINS

A. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted four feet above the floor. Vents in piping systems for fluids containing solids shall be one-inch non–lubricated eccentric plug valves fitted with quick couplers.

B. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted four feet above the floor. Drain valves shall be threaded end gate valves of the size specified. When drains cannot be run to collection points, they shall be routed to a point of easy access and shall have hose gate valves of the size specified.

END OF SECTION

INDEX TO

SECTION 40 27 05.09

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

SECTION 40 27 05.09

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies insulation for exposed piping and related equipment and appurtenant surfaces.

2. All above ground lines require insulation (One-inch minimum. See table in 3.02 for specfics).

B. TEMPERATURE CLASSES:

Insulation for exposed piping and equipment is classified for the following temperature ranges: low, medium, high, and very high.

Low temperature class insulation shall be suitable for an operating temperature range of minus 100 to plus 100 degrees Fahrenheit.

Medium temperature class insulation shall be suitable for an operating temperature range of 100 to 800 degrees Fahrenheit.

High temperature class insulation shall be suitable for an operating temperature range of 800 to 1,200 degrees Fahrenheit.

Very high temperature class insulation shall be suitable for an operating temperature range of 1,200 to 1,800 degrees Fahrenheit.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or

replaced.

Reference	Title
ASTM B209	Aluminum and Aluminum–Alloy Sheet and Plate
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C552	Cellular Glass Thermal Insulation
ASTM E96	Water Vapor Transmission of Materials
FEDSPEC L–P–535E	Plastic Sheet (Sheeting) "Plastic Strip" Poly (Vinyl Chloride) and Poly (Vinyl Chloride–Vinyl Acetate), Rigid
ASTM C547	Mineral Fiber Pipe Insulation

PART 2 –PRODUCTS

2.01 GENERAL

A. Piping insulation shall be tubular type or the flexible blanket type. Insulation for valves, strainers, fittings, expansion joints, flanges and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation, or the flexible blanket type. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

2.02 INSULATION

A. GENERAL:

1. Low temperature class insulation shall be of the unicellular elastomeric thermal, cellular glass, or fiberglass type.

2. Medium temperature class insulation shall be of the cellular glass or fiberglass type.

3. High temperature class and very high temperature class insulation shall be of the calcium silicate type or the flexible blanket type. Piping and equipment subjected to vibration (such as engine exhaust) shall be insulated with flexible blanket type.

B. UNICELLULAR ELASTOMERIC THERMAL TYPE:

1. Unicellular elastomeric thermal type insulation shall conform to the requirements of ASTM C534, Type I.

C. CELLULAR GLASS TYPE:

1. Cellular glass type insulation shall conform to the requirements of ASTM C552, Type II.

D. FIBERGLASS TYPE:

1. Fiberglass type insulation shall conform to the requirements of ASTM C547, Type I, Grade A.

E. CALCIUM SILICATE TYPE:

1. Calcium silicate type insulation shall conform to the requirements of ASTM C533, Type II, Class C.

F. FLEXIBLE BLANKET TYPE:

1. HIGH TEMPERATURE CLASS: High temperature insulation shall be removable one–inch or two–inch thick blanket–type insulation designed for continuous 1,200 degree Fahrenheit service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service. Blanket insulation shall consist of a noncombustible silica cloth jacket and nonasbestos white ceramic fiber insulation. Insulating blanket shall be Hitco AIM, Advanced Thermal Products, SEI Temp–Set 1200, or equal.

2. VERY HIGH TEMPERATURE CLASS: Very high temperature insulation shall be removable one–inch or two–inch thick blanket–type insulation designed for continuous 1,800 degree Fahrenheit service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom–fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service. Blanket insulation shall consist of a noncombustible silica cloth jacket and high purity alumina and silica nonasbestos white ceramic fiber insulation. Insulating blanket shall be Hitco AIM, Advanced Thermal Products, or equal.

2.03 INSULATION JACKETS

A. LAMINATED JACKETS:

1. Laminated jackets shall consist of aluminum and white kraft paper. Jackets shall have a perm rating for water vapor transmission of not more than 0.02 in accordance with procedure A of ASTM E96.

B. ALUMINUM JACKETS:

1. Aluminum jackets shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, 3003, or 3105, temper H16, with integral vapor barrier. Jackets shall be 0.016 inch thick.

2. Sheet metal screws shall be aluminum or stainless steel.

3. Jackets shall be secured with 0.020 by 3/4 inch type 304 stainless steel expansion bands.

2.04 INSULATION COVERS

A. POLYVINYLCHLORIDE (PVC) COVERS:

1. Polyvinylchloride covers shall be one piece, premolded polyvinylchloride.

B. ALUMINUM COVERS:

1. Aluminum covers shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, 3003, or 3105, temper H16, with integral vapor barrier. Covers shall be 0.016 inch thick.

C. SOFT COVERS:

1. Soft covers shall be of the reusable type with TFE–coated fiberglass covers and liner.

2.05 SHIELDS

A. Unless otherwise specified, thermal pipe hanger shields shall be provided at pipe supports. Thermal hanger shields shall be as specified in Section 40 05 15.

2.06 FLASHING

A. Flashing shall include aluminum caps, sealant and reinforcing. Aluminum caps shall be 20 gage thick and shall be cut to completely cover the insulation. Sealants shall be as recommended by the insulation manufacturer.

B. Reinforcement in flashing heated up to 370 degrees Fahrenheit shall be nylon fabric. Reinforcement in flashing for hotter surfaces shall be wire mesh or as recommended by the insulation manufacturer.

2.07 PRODUCT DATA

A. The following information shall be submitted:

1. Manufacturer and manufacturer's type designation.

2. Samples, for each insulation material type, of typical jacket and closures for fittings, valves and appurtenances.

3. Descriptive literature and catalog data for materials to be used showing methods of installation.

4. Certification of ratings for water vapor transmission and puncture and stiffness as specified in paragraph 40 27 05.09–2.03 A.

PART 3 – EXECUTION

3.01 INSTALLATION

A. GENERAL:

1. Insulation shall be applied over clean, dry surfaces. Double layer insulation, where specified or required to achieve the specified surface temperature, shall be provided with staggered section joints.

B. PIPE SUPPORTS AND SHIELDS:

1. Unless otherwise specified, thermal pipe hanger shields shall be provided by the Contractor and installed during pipe support installation. Where thermal pipe hanger shields are used, apply the following to all butt joints:

a. On hot pipe systems, the Contractor shall apply three–inch wide vapor barrier tape or band over the butt joints.

b. On cold water, chilled water, or refrigerant piping, the Contractor shall apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3–inch wide vapor barrier tape or band.

C. PROTECTION:

1. Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.

D. PIPING INSULATION:

1. GENERAL:

a. PIPE: Piping shall be continuously insulated along its entire length including all in–line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Unless otherwise specified, piping insulation shall be provided with laminated jackets specified in paragraph 40 27 05.09–2.03 A. Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive. Jackets shall be provided with their seams located on the underside of pipe.

1. PVC covers specified in paragraph 40 27 05.09–2.04 A shall not be used with medium– or high–temperature class insulation. Removable flexible blanket–type insulation need not be jacketed.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Fitting, connection, flange and valve insulation shall be provided with covers specified in

paragraph 40 27 05.09–2.04. Insulation shall be secured in place with 20–gage wire and a coat of insulating cement. Covers shall overlap the adjoining pipe insulation and jackets. Covers shall be provided with their seams located on the underside of fittings and valves.

2. LOW TEMPERATURE CLASS:

a. PIPE: Insulation shall have ends sealed off with a vapor barrier coating.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Except where soft covers are specified, insulation for pipe sizes two inches and less, shall be provided with rigid PVC covers specified in paragraph 40 27 05.09–2.04 A. Covers shall be sealed at edges with vapor barrier adhesive. The ends of covers shall be secured with vinyl tape. The tape shall overlap the jacket and the cover at least one inch. Vapor barrier shall not be penetrated.

1. Except where soft covers are specified, insulation for pipes two and a half inches and larger shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Covers shall be mechanically secured by corrosion–resistant tacks pushed into the overlapping throat joint.

3. MEDIUM, HIGH, AND VERY HIGH TEMPERATURE CLASS:

a. PIPE: Except for flexible blanket type, insulation shall have ends sealed with end joint strips and held in place by waterproof adhesive.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Except where soft covers are specified, rigid insulation shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Covers shall be mechanically secured by corrosion–resistant tacks pushed into the overlapping throat joint.

4. OUTDOOR PIPING:

a. PIPE: Rigid insulation shall be provided with aluminum jackets specified in paragraph 40 27 05.09–2.03 B. Flexible blanket–type insulation shall be designed for outdoor, weather–exposed service.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Rigid insulation shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Flexible blanket type insulation shall be designed for outdoor, weather–exposed service.

E. MECHANICAL EQUIPMENT INSULATION:

1. GENERAL: Unless otherwise specified, insulation shall fit the contours of equipment and shall be secured with 1/2 by 0.015 inch galvanized steel bands. Weld pins or stick clips with washers may be used for flat surfaces

and spaced a maximum 18 inches apart. Joints shall be staggered and voids filled with insulating cement. Unless otherwise specified, insulation shall be provided with laminated jackets specified in paragraph 40 27 05.09–2.03 A.

a. Unless specifically specified to be uninsulated, equipment connected to insulated piping shall be insulated.

2. OUTDOOR EQUIPMENT: Insulation shall be provided with a coat of weatherproof mastic and a layer of open–weave glass cloth embedded into a wet tack coat. Seams shall overlap at least two inches. A finish coat of weatherproof mastic shall be provided. The total coating thickness shall be a minimum of 1/8-inch.

3. LOW TEMPERATURE CLASS: Insulation shall have joints, breaks, and punctures sealed in facing with fire–retardant vapor barrier adhesive reinforced with four–inch tape.

Insulation shall be provided with a layer of open–weave glass cloth embedded into a wet coat of fire–retardant adhesive. Seams shall overlap at least two inches. A finish coat of fire–retardant adhesive shall be provided.

4. MEDIUM TEMPERATURE CLASS: Joints shall be covered and cemented in place with four–inch–wide strips of the same material as the laminated jackets specified in paragraph 40 27 05.09–2.03 A.

5. HIGH AND VERY HIGH TEMPERATURE CLASS: High and very high temperature equipment shall be covered with custom–fitted removable blanket–type insulation. Blanket–type insulation shall be secured with stainless steel wire lacing and hooks. Ends of blanket segments shall overlap to prevent gaps and voids when the piping and equipment is heated. Blankets shall be snugly secured under nuts and bolt heads to assure complete coverage during operation and to prevent vibration–induced gaps or voids. Blankets shall be secured in strict accordance with the manufacturer's instructions.

F. FLASHING:

1. Flashing shall be provided at jacket penetrations and terminations. Clearance for flashing shall be provided between insulation system and piping supports.

2. A heavy tack coat of sealant shall be troweled over the insulation, extending over the jacket edge 1 inch and over the pipe or protrusion 2 inches. Reinforcement shall be stretched over the tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shall then be troweled over the reinforcement to a minimum thickness of 1/8-inch.

3. Aluminum caps shall be formed to fit over the adjacent jacketing and to completely cover coated insulation. Cap shall be held in place with a jacket strap.

3.02 INSULATION THICKNESS SCHEDULE

A. The insulation dimensional tolerances shall comply with the specified standards. Equipment insulation shall match thickness of attached piping. The minimum insulation thicknesses, exclusive of jacket, shall be as follows:

Piping service	Fluid temperature range, degrees F	Insulation thickness in inches for nominal pipe sizes					
		Runouts up to 2 inches	1 inch and less	1.25 to 2 inches	2.50 to 4 inches	5 and 6 inches	8 inches and larger
Cooling:							
Refrigerant	25–40	1.0	1.0	1.0	1.0	–	–
Process:							
Water & similar	60-100	1.0	1.0	1.5	1.5	1.5	2.0
PA, CA[f]	150–250	1.0	1.0	1.5	1.5	1.5	–
NaOH	60 – 100	1.0	1.0	1.0	–	–	–

[a] See specification Section 40 27 05.
[b] Runouts to individual terminal units (not exceeding 12 feet in length).
[c] Refrigerant insulation by air conditioning equipment supplier.
[f] Insulate piping for personnel protection between compressor and after cooler only. Include drip legs.
[g] For condensation control, see specification Section 40 27 05. Unless otherwise specified, connected equipment shall be uninsulated.
h All above ground lines require a 1-inch minimum thick insulation.

END OF SECTION

INDEX TO

SECTION 40 29 01

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

SECTION 40 29 01

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies manual operators for valves and gates, and operator appurtenances.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C500	Gate Valves 3 through 48 inch NPS, for Water and Sewage Systems

PART 2 – PRODUCTS

2.01 GENERAL

A. Except as specified in valve and gate specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve or gate and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

2.02 OPERATORS

A. GENERAL:

1. Manual operators shall have operating torques less than 80 foot–pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

B. WRENCH NUTS:

1. Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

C. CHAIN WHEELS:

1. Chain wheels shall be ductile iron. Operating chains shall be galvanized.

2.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

1. Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay–put covers.

B. FLOOR BOXES:

1. Floor boxes shall be hot–dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

C. ADJUSTABLE SHAFT VALVE BOXES:

1. Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7–1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

2.04 PRODUCT DATA

A. Manufacturer's catalog information and other data confirming conformance to design and material requirements shall be provided.

PART 3––EXECUTION

3.01 GENERAL

A. Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their

operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.02 OPERATORS

A. GENERAL:

1. Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

B. WRENCH NUTS:

1. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within six inches of the valve box cover.

C. CHAIN WHEELS:

1. Unless otherwise specified, valves with centerlines more than seven feet, six inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within four feet of the specified operating level below the valve. For plug–type valves eight inches and larger, the operator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where the chain may hang in a walkway.

3.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

1. Valve boxes extending to finished surfaces shall be provided for buried valves.

B. FLOOR BOXES:

1. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

INDEX TO

SECTION 40 29 13

BUTTERFLY VALVES

SECTION 40 29 13

BUTTERFLY VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies butterfly valves for air, gas, steam, and water service.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold–Finished, Standard Quality
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber–Seated Butterfly Valves

PART 2 – PRODUCTS

2.01 MATERIALS

A. Valves specified for use in Water shall be considered TYPE A and shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A276, Type 304 Carbon steel, ASTM A108, with stainless steel journals
Disc	Ductile iron, ASTM A536, or cast iron, ASTM A436, type 1 (Ni–Resist); or ASTM A48, Class 40, or ASTM A126, Class B
Seat mating surface	Stainless steel, ASTM A276, Type 304, mounted in body or on disc edge; or Ni–Chrome on the disc edge
Seat sealing surface	Neoprene, EPDM or Buna N
Body	Cast iron, ASTM A126, Class B

B. Valves specified for use in Air shall be considered TYPE B and shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A582, Type 416
Disc	Cast iron, ASTM A126, Class B
Seat sealing surface	Neoprene or Buna N—air and gas services Nordel—(high temp water)
Body	Cast iron, ASTM A126, Class B
Disc edge	Nickel

2.02 MANUFACTURE

A. GENERAL:

1. Valves shall be the stub or through shaft design. Wafer type valves are not acceptable for buried service. Unless otherwise specified, valve flange drilling shall be per ANSI B16.1, Class 125.

B. TYPE A:

1. Type A valves shall be designed in accordance with AWWA C504. Shafts shall be turned, ground and polished. Shaft dimensions and operator torque shall be chosen for the pressure specified in Section 40 27 05 and Class B as specified in AWWA C504. When carbon steel shafts and stainless steel journals are used, static seals shall be provided to isolate the interior of the disc and the shaft from the process fluid.

2. Type A valves, size 3 through 72 inches, shall have seats that are vulcanized, bonded, mechanically secured, or clamped to the body or disc.

C. TYPE B:

1. Valves shall be rated at 175 psig and provide drip tight shutoff up to the full valve rating on dead–end or isolation service. Seat shall be mechanically held in place and shall be field replaceable. Valve ends shall be as specified in Section 40 27 05.

2. Type B valves, size 2 through 20 inches, shall have seats that are bonded to a rigid reinforcing ring.

2.03 MANUAL OPERATORS

A. GENERAL:

1. Manual operators shall be designed in accordance with AWWA C504 and shall have a disc position indicator designating the opened and closed position of the valve.

B. TYPE A:

1. Manual operators for Type A valves shall be of the traveling nut, rack, and pinion, or worm gear type. Operators shall be equipped with adjustable mechanical stop–limiting devices to prevent over travel of the disc in the open and closed positions and shall be self–locking and designed to hold the valve in any intermediate position between full open and full closed. Valve operator components shall withstand an input torque of 300 ft.–lbs. at the extreme operator positions without damage.

2. Operator for buried service shall include an AWWA operating nut and shall be gasketed and grease packed for submerged operation at water pressures to 10 psig. Operators for exposed service shall include a hand wheel and be gasketed for weatherproof service.

C. TYPES B:

1. Operators for Type B valves six inches in diameter and smaller shall be latch lock levers. Valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed.

2.04 PRODUCT DATA

A. Affidavits of compliance with AWWA C504 for Type A valves shall be provided.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 29 19

ECCENTRIC PLUG VALVES

SECTION 40 29 19

ECCENTRIC PLUG VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies eccentric plug valves.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber Seated Butterfly Valves

B. Proof of Design Tests – The Contractor shall furnish the Construction Manager and Engineer of Record three certified copies of a report from an independent testing laboratory certifying successful completion of proof–of–design testing conducted in accordance with AWWA C517–05, except that where the word "disc" appears in the standard, it is understood to mean "plug." In lieu of testing the valves at an independent testing laboratory, proof–of–design testing may be performed at the valve manufacturer's laboratory, but must be witnessed by a representative of a qualified independent testing laboratory, and all test reports must be certified by

the laboratory representative. Proof–of–design testing shall have been performed on not less than three 6–inch diameter valves, with all three test units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.

PART 2 – PRODUCTS

2.01 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body	Cast iron, ASTM A126, Class B
Plug	Cast iron, ASTM A126, Class B, or cast iron ASTM A436 (Ni–resist), or ductile iron, ASTM A536
Plug facing	Neoprene or Buna–N
Body seats	
Less than 3 inches	Cast iron, ASTM A126, Class B
3 inches and larger	Stainless steel, ASTM A276, Type 304 or nickel
Packing	Buna V–flex or TFE

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.02 MANUFACTURER

A. General – Valves shall be straight–flow, non–lubricated, resilient plug type suitable for drip-tight, bi–directional shutoff at the specified valve design pressure. Port areas for the valve shall be at least 80% of the adjacent full pipe area. Valve body seats consisting of nickel for valves three inches and larger shall be constructed of a welded–in overlay of not less than 90% pure nickel. Upper and lower journal bearings shall be replaceable, sleeve–type, corrosion resistant, and permanently lubricated. Packing shall be self–adjusting, chevron-type, replaceable without disassembling the valve.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Design pressure, psig
12 and smaller	175
14 through 36	150
42 through 54	125

B. End Connections – Valves three inches and smaller shall have threaded ends. Valve flange drilling for valves larger than three inches shall be per ANSI B16.1, Class 125. Grooved–end valves may be provided with grooved–end piping systems.

C. Manual Operators – Unless otherwise specified, valves four inches and smaller shall be provided with a lever type manual operator. Valves larger than four inches shall be provided with totally enclosed worm gear operators. Where specified, manual operators shall have an adjustable stop. All operator components shall be sized for the valve design pressure in accordance with AWWA C504, Section 4.5. Operators shall comply with applicable portions of Section 40 29 01.

2.03 PRODUCT DATA

The following information shall be provided:

A. Manufacturer's product data.

B. Proof–of–design test reports specified in paragraph 40 29 19–1.02 B.

PART 3 – EXECUTION

Unless otherwise specified, valves shall be provided with the seat downstream away from flow. Valves at tank connections shall be installed with seat away from tank. Valves on pump discharge lines shall be installed with seat adjacent to the pump.

END OF SECTION

INDEX TO

SECTION 40 29 27

NONCLOG BALL CHECK VALVE

SECTION 40 29 27

NONCLOG BALL CHECK VALVE

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies nonclog ball check valves.

B. TYPE:

1. The nonclog check valves shall consist of three components: body, cover, and ball—one moving part. The design of the valve shall keep solids, stringy material, grit, rags, etc., moving without the need for backflushing. The ball shall clear the waterway providing "full flow" equal to the nominal size. There shall be no outside levers, weights, springs, dashpots, or other accessories.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Flygt and Golden Anderson, or equal.

2.02 COMPONENTS

A. BODY AND COVER:

1. Valve body and cover shall be of gray cast iron or ductile iron. Flange drilling shall be according to ANSI B16.1, Class 125.

B. BALL:

1. The valve ball shall be hollow steel with an exterior of nitrile rubber. It shall be resistant to grease, petroleum products, animal and vegetable fats, diluted concentrations of acids and alkalines (pH 4 to 10), tearing, and abrasion.

2.03 PRODUCT DATA

A. Submit product information and applicable operation and maintenance information for review.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 29 50

SPECIALTY VALVES

SECTION 40 29 50

SPECIALTY VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies specialty valves which are auxiliary to process piping systems.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME SEC VIII D2	Boiler and Pressure Vessel Code, Pressure Relief Devices
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings

PART 2 – PRODUCTS

2.01 MUD VALVES

A. Mud valves shall be of the heavy duty flange type with rising or non-rising stems as shown on the plans. Frame, cover, yoke and stem extension connection shall be stainless steel. Stems shall be stainless steel. Lift nuts shall be bronze. On non-rising stem models the stem is to be protected by a stainless steel shroud with drain hole. Valve shall be operated by a tee handle, hand wheel, or with stainless (mild steel) stem extension to the height required. On rising stem valves, stem guides shall be provided such that the L/R ratio of the unsupported part of the stem shall not exceed 200. Pedestal lifts, stem guides, and wall brackets shall be furnished by mud

valve manufacturer to make a complete and operable unit. Mud valves shall be Waterman MV–11, Trumbull 367-1351 or equal.

2.02 PRESSURE RELIEF VALVES

A. Pressure relief valves for air shall be ASME certified, Watts Fig 41A, Lonergan L14/L40 Series, or equal. Size and pressure settings shall be as specified or as required for the service intended. Pressure relief valves for cold and hot water shall be McDonnell and Miller 230, Watts 174A, Cash Acme F–82, Lonergan L14/L40 Series, or equal.

2.03 HOSE VALVES

A. Unless specified otherwise, hose valves shall be a brass angle valve, composition disc, Crane 17, Lunkenheimer 214, Powell 151, or equal with threaded nipple adapter for hose connection.

2.04 FLUSHING COCKS

A. Flushing cocks shall consist of a DeZurik 159/118–S, Keystone Fig 541, or equal, neoprene–faced eccentric plug valve with a hose nipple adapter if required. Unless specified otherwise, flushing cocks shall be 1 inch in diameter.

2.05 QUICK DISCONNECTS

A. Quick disconnects shall not be disconnectable under pressure. Quick disconnects for air service shall be Swagelok, Tomco, or equal, and shall be 1/2 inch, unless otherwise specified. Quick disconnects for water service shall be EverTite Part B, Gate Part B, or equal, and shall be 1 inch, unless specified otherwise.

2.06 PRODUCT DATA

A. Provide product data for approval.

PART 3 – EXECUTION

3.01 EXECUTION

A. Specialty valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 31 00

FABRICATED STAINLESS STEEL SLIDE GATES

SECTION 40 31 00

FABRICATED STAINLESS STEEL SLIDE GATES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies self–contained Stainless Steel Downward Opening Weir Gates and gate operators.

B. TYPE:

Slide gates shall be of fabricated stainless steel construction, with gates, guides, and operators provided by one manufacturer. Gates shall meet the leakage requirements of AWWA C513.

The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation and shall be the latest standard product of a manufacturer regularly engaged in the production of water control gates.

C. DESIGN CONDITIONS:

Self–contained slide gates shall be designed for continuous exposure to raw municipal wastewater. Fluid temperature is expected to range from 60 degrees F to 80 degrees F. The gates will be installed outdoors in a municipal wastewater treatment plant near the ocean.

D. OPERATING REQUIREMENTS:

Equipment number	Gate size, inch (a)	Gate type (b)	Opening direction (c)	Bottom seating (d)	Design head, feet		Operator type (e)
					Seating	Unseating	
WEG–050101	24 x 18	W	D	J	1	0	HW
WEG–050201	24 x 18	W	D	J	1	0	HW
WEG–230101	24 x 18	W	D	J	1	0	HW
WEG–230102	24 x 18	W	D	J	1	0	HW

Notes:

[a] Width by height.

[b] C = channel–mounted, W = wall–mounted
[c] U = upward, D – downward
[d] FB = flush bottom, J = J–seal on invert
[e] GC = geared crank type, HW = hand wheel type

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Notice Inviting Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME	American Society of Mechanical Engineers
ASTM 240	Heat–Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable
ASTM D2000	Rubber Products in Automotive Applications
ASTM D4020	Ultra–High–Molecular–Weight Polyethylene Molding and Extrusion Materials
AWWA C513	Open–Channel, Fabricated Metal Slide Gates

B. SUBMITTALS:

The following information shall be submitted for approval:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check–marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to

a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked–up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Fabrication drawings with full dimensions.

3. Plan, cross section, and details showing proposed mounting for each size and typical application of gate.

C. MANUFACTURING:

Manufacturer's welders shall be certified per ASME, Section 1X or American Welding Society.

D. EXPERIENCE:

Manufacturer shall have a minimum of ten years' experience with the fabrication of the model of gate provided. Submit installation list of the model of gate provided to confirm this requirement.

PART 2––PRODUCTS

2.01 PRODUCTS

Fabricated stainless steel weir gates shall be Whipps, Hydro Gate, Rodney Hunt, Fontaine, Waterman, or equal, modified as necessary to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Materials for components shall be as follows:

Component	Material
Frames, slides, rails, and yokes	ASTM A276 or ASTM A240, Type 316L Stainless Steel
Fasteners and anchor bolts	ASTM A276, Type 316 Stainless Steel
Stems	ASTM A276, Stainless Steel, Type 304, 303 MX, or 316
Stem Guides	ASTM A276, Stainless Steel, Type 304L or 316L, with bronze or UHMW Polyethylene bushing

Component	Material
Seals	ASTM D2000, Grade AA625, Buna–N or neoprene rubber, or ASTM D4020 UHMW Polyethylene

2.03 EQUIPMENT FEATURES

A. GENERAL DESIGN. Weir gates shall be self–contained, and of the rising stem or non–rising stem configuration. Design stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the materials at maximum load conditions. Minimum thickness of slide, its reinforcing members, and all structural components of the guide and frame shall be 0.25 inches.

B. FRAME. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one–piece frame. The frame shall be of the flange back design, suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).

C. SLIDE. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head. The gate frame shall be a rigid, welded unit, composed of the guide rails, cross bars, and deadrails, with a clear opening the same size as the waterway, unless otherwise specified. They shall be integral flange back or embedded type. The guides will be of sufficient length to support two–thirds (2/3) the height of the slide, when the gate is fully open. On wall mounted gates, compressible gaskets or grout shall be provided between frame and wall as needed to ensure full mating of surfaces and no leakage.

Where the guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcing will be required. The yoke to support the operating device shall be formed by members welded or bolted at the top of the guides. The arrangement of the yoke shall be such that the slide and stem can be removed without disconnecting the yoke. When the slide is too long to allow this, the yoke shall be bolted for easy removal.

D. GUIDES AND SEALS. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

The bottom and side seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self–adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate.

Seals shall maintain the specified leakage rate in both seating and unseating conditions.

E. OPERATOR STEM AND COUPLINGS. The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40 lbs (178 N) effort on the crank or hand

wheel.

The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machine cut threads of the Acme type.

For stems in more than one piece and with a diameter of 1 ¾ inches (45 mm) and larger, the different sections shall be joined together by solid bronze couplings. Stems with a diameter smaller than 1 ¾ inches, shall be pinned to an extension tube.

The couplings shall be grooved and keyed and shall be of greater strength than the stem.

Gates having width equal to or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

F. STEM GUIDES. Stem guides shall be fabricated from type 304L (or 316L) stainless steel. The guide shall be equipped with an UHMWPE bushing. Guides shall be adjustable and shall be spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

G. STEM COVER. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

H. LIFTING MECHANISM. Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.

Operators shall be hand wheel type. Operators shall meet AWWA C501 specifications, except as otherwise specified. Gears, and bearings shall be enclosed in a weatherproof housing, and pressure type fittings shall be provided for grease lubrication of the bearings and gears. A maximum effort of 40 pounds pull of the crank or hand wheel shall operate the gate under the specified operating conditions.

The operator shall be either pedestal or bench mounted as specified. Pedestal type floor standards shall be the offset type or the standard type with wall mounting bracket. Pedestal or bench stands shall be cast iron. The head of the pedestal or bench stand operator shall have a solid bronze, internally threaded operating nut. The operator shall be mounted on anti friction roller bearings. Cranks and handwheels shall be removable from the operator. Hand crank operators shall be provided with a 2–inch AWWA operating nut in horizontal appropriate for use with portable electric operators.

I. YOKE. Self–contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span. The yoke shall be sufficiently strong to support the lift forces when subjected to a load of 100 pounds pull on the operator. The yoke shall be designed so that its deflection under full operating load will not exceed 1/360 of the gate width.

J. MATERIALS

PART	MATERIAL
Frame, yoke, stem guides, slide, stem extension	Stainless steel ASTM A–240 type 304L or 316L
Guides, side and bottom seals, stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D–4020
Compression cord	Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
Threaded stem	Stainless steel ASTM A–276 type 303 MX or 316
Fasteners	ASTM F593 and F594 GR1 for type 304 and GR2 for type 316
Pedestal, hand wheel and crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D–3935
Lift nut, couplings	Manganese bronze ASTM B584 UNS–C86500

2.04 PRODUCT DATA

The following information shall be submitted for approval:

1. Product information, charts, or graphs to verify that the product provided meets the requirements set forth in the specification.

2. Affidavits of compliance in accordance with AWWA C513.

3. Applicable operation and maintenance.

PART 3––EXECUTION

3.01 INSTALLATION

Unless otherwise specified, self–contained slide gates shall be installed in accordance with manufacturer's instructions.

3.02 TESTING

For purpose of this specification, field leakage tests shall be performed as specified in Section 6.3 of AWWA C513.field leakage tests shall be conducted with no head on one side of the gate being tested.

Gate shall be operated through a minimum of two cycles, to confirm operation. Limit switches and other stops shall be adjusted per the manufacturer’s recommendations.

END OF SECTION

INDEX TO

SECTION 40 31 05

FRP WEIRS

SECTION 40 31 05

FRP WEIRS

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section provides detailed specifications for weirs fabricated from fiber reinforced thermoset plastic (FRP).

1.02 QUALITY ASSURANCE

A. REFERENCE:

1. The FRP items to be provided under this section shall meet the applicable requirements of AWWA F102–96, Type II.

B. SERVICE CONDITIONS:

1. The weirs to be furnished under this specification will be installed in a membrane bioreactor tank in a municipal wastewater treatment plant. The wastewater is expected to contain finely divided organic solids, dilute industrial solvents and petroleum products, animal fats and greases, vegetable oils, trace quantities of chlorine, dissolved hydrogen sulfide gas in concentrations up to 20 milligrams per liter, and oxygen may be either present or absent. During the normal life of these laminants, they will be exposed to the weather, including sunlight, both with and without liquid in the tank, and may be left in the dry condition for protracted periods. It is possible that dilute sulfuric acid may be present and may collect on any surface. Wastewater temperatures are expected to vary between 55 and 70 degrees Fahrenheit. The surface temperature of the weirs are expected to reach 120 degrees Fahrenheit when the tank is drained.

1.03 SUBMITTALS

A. The following shall be submitted for approval:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check–marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (_) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked–up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be

sufficient cause for rejection of the entire submittal with no further consideration.

2. Shop drawings showing equipment dimensions and materials of construction.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Materials used shall be per AWWA F102–96.

2.02 MANUFACTURE

A. DIMENSIONS:

1. The two weir plates shall be 72 inches wide by 12 inches high.

B. FABRICATION:

1. FRP weirs shall be fabricated by the matched–die molding process per AWWA F102–96. The final weir plate thickness shall be at least 1/4 inch. Slotted bolting holes shall be provided as shown to allow adjustment and leveling. Mounting shall permit expansion and contraction through the range of temperatures specified.

PART 3 – EXECUTION

3.01 EXECUTION

A. Field cutting of weir notches shall not be permitted. All field cuts required for installation shall receive two sealing coats.

B. Weirs shall be mounted, with gasket material, and leveled to a tolerance of plus or minus 0.01 foot during freshwater testing when the tank contains water to the normal operating level. Provisions shall be made to accommodate thermal expansion and contraction through the use of expansion joints at each weir plate joint.

END OF SECTION

INDEX TO

SECTION 40 80 01

PROCESS PIPING LEAKAGE TESTING

SECTION 40 80 01

PROCESS PIPING LEAKAGE TESTING

PART 1 – GENERAL

1.01 SUBMITTALS

A. Information Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.

   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Test type.
   d. Method of isolation.
   e. Calculation of maximum allowable leakage for piping section(s).

2. Certifications of Calibration: Testing equipment.

3. Certified test report.

1.02 QUALITY ASSUERNCE

A. Testing shall be by a testing laboratory which operates in accordance to ASTIM D 3740 or E 329 and shall be acceptable to Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regular scheduled tests, spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making test.

B. Infiltration, line and grade of sewer, pump performance; hydrostatic test on force mains and water mains and all other tests shall be made by the Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing five days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.

2. Wait seven days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to three days.

3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

4. New Piping Connected to Existing Piping:

a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.

b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

5. Items that so not require testing include tank overflows, and tank atmospheric vents.

6. Test Pressure: As indicated on in each section, and other sections (min. 150 psi)

C. Test section may be filled with water and allowed to stand under low pressure prior to testing. Contractor shall pretest prior to requesting an official test.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.

2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TESTING FOR PRESSURE PIPING

A. Fluids: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.

2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

4. Maintain hydrostatic test pressure continuously for 120 minutes minimum, and for such additional time as necessary to conduct examinations for leakage.

5. Examine joints and connections for leakage.

6. Correct visible leakage and retest as specified.

7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.

2. Expel air from piping system during fill.

3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

4. Maintain hydrostatic test pressure continuously for two hours minimum, reopening isolation valve only as necessary to restore test pressure.

5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

D. Hydrostatic and Leakage Tests – Ductile iron pipe shall be tested in accordance with AWWA Standard C 600, Section 5.2 – Hydrostatic Testing. Allowable leakage shall not exceed the formula $L = SDP^{1/2}/148{,}000$, in which L is allowable leakage in gallons per hour; S is length of pipe in feet tested; D is nominal diameter of pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least two hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

E. P.V.C. pipe shall be tested in accordance with AWWA Standard C 605, Section 7.3 – Hydrostatic Testing. Allowable leakage shall not exceed formula $Q = LDP^{1/2}/148{,}000$, in which Q is allowable leakage in gallons per hour; L is length of pipe in feet tested; D is nominal diameter of the pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least two hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

1. Should any test of pipe laid disclose leakage greater than the above specified, Contractor shall, at its own expense, locate and repair defective joints until leakage is within specified allowance. Contractor is responsible for notifying the Engineer 48 hours (minimum) prior to applying pressure for testing. Pressure test will be witnessed by Engineer or Project

Representative. All visible leaks shall be repaired regardless of the leakage amount.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.

2. Piping larger than 18 inches.

3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.

2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase in steps of approximately one-tenth of specified test pressure until required test pressure is reached.

4. Maintain pneumatic test pressure continuously for minimum of ten minutes and for such additional time as necessary to conduct soap bubble examination for leakage.

5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visible evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 DEFLECTION FOR GRAVITY PIPING

A. It is the Contractor's responsibility to assure backfill is sufficient to limit pipe deflection to no more than five percent. When flexible pipe is used, a deflection test shall be made by Contractor on the entire length of installed pipeline, not less than 30–days after completion of all backfill and placement of any fill. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 95 percent of the inside pipe diameter. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a

density greater than 1.0 as related to water at 39.2 degrees Fahrenheit, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4-inch minimum diameter steel shaft having a yield strength of 70,000 p.s.i. or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on opposite end of shaft shall produce compression throughout remote end of ball, cylinder, or circular section. Circular sections shall be spaced so distance from the external faces of front and back sections shall equal or exceed diameter of circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through by hand or by being flushed through with water, shall be cause for rejection of individual run. When a deflection device is used for the test in lieu of a ball, cylinder, or circular sections described, such device shall be acceptable to Engineer prior to use. Device shall be sensitive to 1.0 percent of diameter of pipe being measured and shall be accurate to 1.0 percent of indicated dimension. Installed pipe showing deflections greater than five percent of the normal diameter of pipe shall be retested by a run from opposite direction. If retest also fails, the suspect pipe shall be repaired or replaced at no cost to Owner. 100 percent of the pipe shall be tested.

3.05 LEAKAGE FOR GRAVITY PIPING

A. In no stretch of sewer between any two adjoining manholes shall infiltration/exfiltration exceed 25 gallons per day per inch of pipe diameter per mile of pipe. In case leakage exceeds this amount, the sewer shall not be accepted until such repairs and replacements are made to comply with above requirements. Such corrections will be made at the Contractor's expense. All visible leaks shall be repaired, regardless of the amount of leakage.

B. Lines shall be tested for leakage by low pressure air testing, infiltration tests, or exfiltration tests, as appropriate. Low pressure air testing for PVC pipe shall be as prescribed in ASTM F 1417. Prior to infiltration or exfiltration tests, trench shall be backfilled up to at least the lower half of pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When water table is two feet or more above top of pipe at upper end of pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to Engineer. When Engineer determines infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so a head of at least two feet is provided above both water table and top of pipe at upper end of pipeline to be tested. The filled line shall be allowed to stand until pipe has reached its maximum absorption, but not less than four hours. After absorption, the head shall be re–established. The amount of water required to maintain this water level during a two hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Owner.

C. The Contractor shall furnish equipment and plugs and subject force mains to hydrostatic tests at 100 p.s.i. for a period of two hours. Any leaks shall be located and repaired. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. No pipe installation will be accepted until leakage during pressure test is less than the number of gallons listed for each 1000–feet of pipe tested:

6 inches & less – 0.9 gallons	12 inches – 1.80 gallons
8 inches – 1.20 gallons	14 inches – 2.10 gallons
10 inches – 1.50 gallons	16 inches – 2.40 gallons

100 percent of the pipe shall be tested.

3.06 DISINFECTION FOR WATER MAIN

A. After hydrostatic and leakage tests have been completed, water pipes shall be disinfected in accordance with AWWA C 651 and Regulations of the local Health Department.

B. All new mains shall be thoroughly flushed then chlorinated with not less than fifty parts per million (50 ppm) of available chlorine. Chlorine gas or 70 percent high–test calcium hypochlorite can be used. Water from existing distribution system or other source of supply should be controlled to flow slowly into the newly laid pipeline during application of chlorine. The solution shall be retained in pipeline for not less than 24 hours and a chlorine residual of 25 ppm shall be available at this time. Then system shall be flushed with potable water and the sampling program started. Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non–detectable in those systems not chlorinating. Normal system residual should be between 0.2 and 0.8 ppm. The chlorine residual shall be measured and reported. If the membrane filter method of analysis is used for coliform analysis, non–coliform growth must also be reported. If non–coliform growth is greater than eighty colonies per one hundred milliliters, the sample result is invalid and must be repeated.

C. A minimum of two samples from each sampling site shall be collected for total coliform analysis. The number of sites depends on amount of new construction, but must include all dead end lines, be representative of water in newly constructed mains, and shall be collected a minimum of every 1,200 linear feet. Each set of samples shall be taken at least 24 hours apart after disinfection and tested by a State approved lab and shall indicate bacteriological satisfactory water. Contractor shall submit results to the Engineer.

3.07 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.

3. Test fluid.

4. Test pressure.

5. Remarks, including:

   a. Leaks (type, location).

   b. Repair/replacement performed to remedy excessive leakage.

6. Signed by Contractor and Engineer to represent that test has been satisfactory completed.

END OF SECTION

INDEX TO

SECTION 40 91 00

PROCESS INSTRUMENTATION

SECTION 40 91 00

PROCESS INSTRUMENTATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor
-	Process and Instrumentation Diagrams (P&IDs)

1.02 SCOPE

A. The Contractor shall furnish and install all instrumentation and instrumentation installation hardware, conduit, and wiring necessary to provide for the complete installation of all instrumentation described in this specification. At a minimum the Contractor shall be responsible for:
1. Purchasing of all instrumentation tagged on the P&ID drawings, instrumentation schedule, or others listed in these specifications.
2. Installation and termination of all instrument and power wiring.
3. Installation and connection of all instrument pneumatic tubing and related controls.
4. Performance of instrument calibration and loop checks.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports, or independent support framing, secured together, and anchored in place.

F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

1.03 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:
   1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.
   2. A complete set of submittal information in PDF format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.04 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting & installation information, electrical connection information, calibration instructions, maintenance information, and a trouble shooting guide.

PART 2 – PRODUCTS

2.01 DISSOLVED OXYGEN SENSOR/TRANSMITTER

A. Sensor
   1. The sensor shall be a continuous-reading probe that utilizes luminescent sensor technology.
   2. All parts of the probe shall be corrosion resistant and fully-immersible.
   3. The measurement range shall be 0.00 to 20.00 mg/L dissolved oxygen.
   4. The operation of the analyzer shall not be affected by H2S, pH, K+1, Na+1, Mg+2, Ca+2, NH4+1, Al+3, Pb+2, Cd+2, Zn+2, Cr (total), Fe+2, Fe+3, Mn+2, Cu+2, Ni+2, Co+2, CN-1, NO3-1, SO4-2, S-2, PO4+3, Cl-1, anion active tensides, crude oils, or Cl2-1.
   5. The probe shall provide electrolyte-free operation without the requirements of sample conditioning.
   6. The sensor cap shall be warranted for one full year against defects in material and workmanship.

7. The probe shall be warranted for three full years against defects in material and workmanship.
8. Sensor shall be self-calibrating with a response time to 90% in less than 430 seconds or to 95% in less than 60 seconds at 20 degrees C.
9. Measurement accuracy shall be approximately.1ppm below 1 ppm and approximately .2 ppm above 1 ppm.
10. The sensor shall be approved for operation from 32 to 122 degrees F.

B. Controller/Transmitter
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. Hach LDO sensor with SC100 controller.
2. Approved equal.

2.02 TURBIDITY SENSOR/TRANSMITTER

A. Sensor
1. The turbidimeter shall be a microprocessor-based, continuous reading, on-line nephelometric instrument
2. The turbidimeter shall measure turbidity in the range of 0.001-100 NTU
3. Accuracy shall be approximately 2% of reading or approximately 0.015 NTU (whichever is greater) from 0 to 40 NTU; approximately 5% of reading from 40 to 100 NTU
4. Displayed resolution shall be 0.0001 NTU from 0 to 9.999 NTU and 0.001 NTU from 10.000 to 9.999 NTU.
5. Repeatability shall be better than approximately 1.0% of reading or approximately 0.002 NTU (whichever is greater).
6. The turbidimeter shall meet all design and performance criteria specified by USEPA method 180.1.
7. Light shall be directed through the surface of the sample and the detector shall be immersed in the sample, eliminating glass windows and flow cells.
8. Optical components shall be mounted in a sealed head assembly that can be removed for calibration/ service without disturbing sample flow.
9. The turbidimeter body shall be corrosion-resistant.
10. An internal bubble removal system shall be included to vent entrained air from the sample stream.

11. Calibration of the turbidimeter shall be either formazin-based (20 or 1 NTU) or instrument comparison-based calibration method.
12. User selectable signal averaging, bubble removal, alarm and recorder output hold, and self-test diagnostics shall be provided.
13. Connections between the turbidimeter(s) and the controller shall be "plug and play."
14. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
15. The interface unit shall include two analog outputs and 3 unpowered SPDT alarm contacts.

B. Controller/Transmitter
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. Hach 1720E with SC100 controller.
2. Approved equal.

2.03 MIXED LIQUOR SUSPENDED SOLIDS (MLSS) SENSOR/TRANSMITTER

A. Sensor
1. The sensor shall use dual-beam infrared/scattered light photometer for measuring suspended solids. The LED shall transmit light at 45 degrees to the sensor face and the back-scatter photoreceptors shall detect scattered light at 140 degrees to the transmitted beam.
2. The sensor shall provide color-independent measurement.
3. The sensor shall be equipped with self-cleaning device to prevent erroneous values and maintenance problems.
4. The signal averaging time shall be user selectable ranging from 1 to 300 seconds.
5. The sensor shall be capable to measure from 0.001 mg/l to 50,000 mg/L.
6. Measurement accuracy shall be less than 5% of reading.
7. Measurement repeatability shall be less than 3% of reading.
8. The sensor shall be approved for operation from 32 F and 104 F.
9. The sensor shall be warranted for one full year.
10. The sensor shall be enclosed in stainless steel or PVC and shall include a silicon wiper blade and integral cable.

B. Controller
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. HACH SOLITAX with SC100 controller.
2. Approved Equal.

2.04 pH SENSOR/TRANSMITTER

A. Sensor
1. The pH sensor shall be of differential electrode technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling resistant characteristics.
2. The pH sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 100 meters (328 feet) with standard cabling and up to 1000 meters (3280 feet) with a termination box.
3. The pH sensor shall have NTC 300 ohm thermistor for automatic temperature compensation and shall have a analyzer temperature readout.
4. The measurement range shall be -2 to 14 pH.
5. The measurement sensitivity shall be approximately 0.01pH.
6. The sensor shall be suitable for operation from 23 F to 158 F.
7. The sensor material shall be PEEK®, salt bridge of matching material with Kynar® junction, glass process electrode, titanium ground electrode, and Viton® O-ring seals.

B. Controller
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. HACH Differential pH with SC100 controller.
2. Approved equal.

2.05 HYDROSTATIC LEVEL TRANSMITTER

A. The level transmitter shall be a hydrostatic pressure sensor with an integral baffle plate to protect the sensing element from debris.

B. The level transmitter shall measure up to 23 feet of water head.

C. The level transmitter shall have a static accuracy of 0.5% FSO BFSL and one year stability of 0.20% FSO.

D. The response time shall be less than 5 ms.

E. The signal output shall be 4-20 mA DC two wire twisted pair grounded shield cable at 0.042 ohm per foot.

F. The transmitter shall be approved for operation from -20 F to 190 F.

G. The transmitter and sensor shall be made of 316 stainless steel. The cable shall be polyurethane-jacketed cable with 40 feet of length.

H. The transmitter shall require 10-30 VDC unregulated power.

I. Manufacturers
1. Blue Ribbon Bird Cage Level Transmitter.
2. Endress and Hauser FMX Level Transmitter.
3. Approved equal.

2.06 ULTRASONIC LEVEL TRANMITTER

A. The transmitter shall use the Sonic Intelligence® echo processing technology.

B. The measuring range shall be 0.8 feet to 26 feet.

C. The accuracy shall be 0.25% of measuring range (in air).

D. The transmitter shall be suitable for operation under ambient temperature conditions from -40 F to 140 F and shall include built-in temperature compensation.

E. The Power supply required for the transmitter shall be 12 to 28 V DC, max 0.1 A. The max power consumption shall be 0.75 W (25 mA at 24 V DC).

F. The output signal shall be 4-20mA and max load shall be 600Ω in the loop at 24 V DC.

G. The transmitter shall have CE, CSA $_{NRTL/C}$, FM and 3A certificates, and approvals.

H. The transmitter electronics enclosure shall be made of PVC and transducer shall be made of PVDF copolymer.

I. Manufacturers
   1. Siemens Milltronics Level Transmitter.
   2. Approved equal.

2.07 LEVEL SWITCH

A. The level switch shall be an enclosed, narrow angle, mechanical float switch designed for use in sewage environments.

B. The level switch shall utilize mechanically-activate microswitches for indication of specific water levels. Level switches containing mercury shall not be acceptable.

C. The switches shall be a single-pole, double throw (SPDT) type and have an electrical rating of 10 amps at 120 VAC.

D. The power cord shall be chlorinated polyethylene type SJ00W-300 volt on 16/3.

E. The float shall be ABS or polypropylene material and shall be leak proof, shock proof, and impact resistant.

F. The level switches shall be supplied with an anchor to which the float shall be tethered. The anchor shall allow for adjustment of the actuation level and be of sufficient weight as to hold the floats secure in a well-mixed tank. The anchor shall be constructed of corrosion-resistant material suitable for continuous submergence in mixed liquor.

G. Manufacturers
   1. Conery 2902 Series Mechanical Angle float switches.
   2. Kobold NAE Series float switches.

2.08 TEMPERATURE SWITCH

A. The enclosure material shall be Die cast aluminum, epoxy powder coated, gasketed, and with captive cover screws.

B. The enclosure shall meet NEMA 4X requirements.

C. The set point repeatability shall be within approximately1% of adjustable temperature range.

D. The output shall be SPDT snap action switch.

E. The switch shall be electrically rated for 20A 125/250/480 VAC resistive.

F. The temperature dead band shall be within 2% of range under laboratory conditions (70 F ambient circulating bath at rate of ½ F per minute change).

G. The immersion stem shall be made of nickel-plated brass.

H. Manufacturers
   1. United Electric.
   2. Approved equal.

2.09 TEMPERATURE GAUGE

A. The temperature gauge shall be hermetically sealed to prevent moisture entry into the casing.

B. The temperature gauge shall be tamperproof with Maxivision dial for accurate temperature readings.

C. The temperature gauge shall be suitable for use in ambient temperature between -40 F and 200 F.

D. The temperature gauge shall measure temperature from 50 F to 400 F.

E. The temperature gauge accuracy shall be 1% full span to ASME B40.3 (Grade A).

F. The bimetal coils used are heat treated for optimum stability and over temperature capability.

G. The temperature gauge case and stem material shall be 304 SS.

H. Manufacturers
   1. Ashcroft Bimetal Thermometers.
   2. Approved equal.

2.10 FLOW SENSOR/TRANSMITTER FOR PERMEATE AND MIXED LIQUOR SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 feet per second shall be approximately 0.5% of rate approximately 0.02% of full scale (33 feet per see) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from ½-inch to 78 inches.

E. The tube shall be lined with polyurethane and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges

shall be ANSI B16.1 Class 150 for 12 inches and smaller and AWWA Class D for 14 inches and larger.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of 316SS material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16 character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers
1. Endress & Hauser Model 50W.
2. Approved equal.

2.11 FLOW SENSOR/TRANSMITTER FOR CLEAN-IN-PLACE CHEMICAL SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 feet per second shall be approximately 0.5% of rate approximately 0.02% of full scale (33 feet per see) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 1 inch -12 inches.

E. The tube shall be lined with PTFE and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges shall be ANSI B16.1 Class 150 for 12 inches.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of Alloy C-22 material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The transmitter shall be a three stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16 character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units. The display shall be used in conjunction with integral push buttons for configuration and diagnostic messages.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers
   1. Endress & Hauser Model 50P.

2. Approved equal.

2.12 ROTAMETER (LIQUID SERVICE)

A. The liquid rotameter shall be a variable-area style flow meter.

B. The rotameter shall be rated for service up to 145 psig and temperatures up to 140 degree F with an accuracy of approximately 4% of full scale.

C. The rotameter shall have a polysulfone measuring tube with a direct reading scale which is calibrated for measurement in gallons per minute.

D. The rotameter shall be supplied with PVC socket x half union connections.

E. The float shall be PVDF.

F. The rotameter shall be supplied with EPDM o-rings.

G. Manufacturers
1. Kobold KSM series
2. Approved equal.

2.13 FLOW SENSOR/TRANSMITTER FOR AIR SERVICE

A. The flow meters shall be an insertion-style with an integrally-mounted transmitter.

B. The voltage shall be linearly proportional to flow velocity from 0.65 to 275 feet per second. Standard accuracy of the pulse output between .65 and 275 feet per second shall be approximately 1.5% of reading approximately 0.5% of full scale (275 Feet Per Second) for all meters. The installation location shall meet the manufactures installation guidelines for straight run requirements with and without using a flow conditioner.

C. The air flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 3 inches to 60 inches.

D. The metering mechanism shall be manufactured of 316 Stainless steel sensors shall be of the proper sizes to measure the design flow rate of the piping and shall be noted in the instrument schedule.

E. Repeatability .5% for velocities above .65 feet per second.

F. The transmitter shall be a three stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC, 45 to 65 Hertz. or 20 to 55 V AC, 45 to 65 Hertz, or 16 to 62 V DC transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

G. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient

protection. Power consumption shall be no more than 16 VA, independent of meter size.

H. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

I. Each meter shall be provided with a certificate of a 3-point calibration report exceeding stated accuracy of 1.5% of reading for 100% to 20% of full scale at reference conditions, .3% of full scale for 20% to 1% of full scale at reference conditions.

J. Manufacturer
1. Endress Hauser Model 65I.
2. Sierra Model 640S.
3. Approved equal.

2.14 ROTAMETER (AIR SERVICE)

A. The air flow rotameter shall be a glass tube variable-area style flow meter.

B. The rotameter shall be rated for service up to 100 psig and temperatures up to 212 degree F with an accuracy of approximately - 1% of full scale.

C. The air flow rotameter shall have a tempered glass measuring tube with a direct reading scale which is calibrated for measurement of air in SCFH.

D. The rotameter shall be supplied with 316 stainless steel 150 lb ANSI flanges.

E. The float shall be 316 stainless steel

F. The rotameter shall be supplied with EPDM orings.

G. Manufacturers
1. Kobold KDV series.
2. Approved equal.

2.15 PRESSURE SENSOR/TRANSMITTER FOR LIQUID SERVICE

A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus 5% zero point adjustment with no on site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum

deflection of the ceramic diaphragm shall not exceed 0.001 inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be approximately 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4...+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers
1. Endress+Hauser PMC131.
2. Approved equal.

2.16 PRESSURE SENSOR/TRANMITTER (AIR SERVICE)

A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus 5% zero point adjustment with no on site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum deflection of the ceramic diaphragm shall not exceed 0.001 inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be approximately 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4...+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers
1. Endress+Hauser PMC131.
2. Approved equal.

2.17 PRESSURE SWITCH

A. The pressure switch shall feature diaphragm sensing technology, a 20 amp snap-acting switch, and adjustable pressure ranges up to 475 psi.

B. The pressure switch should be able to operate in 0 to 160 F (17 to 71 C). Set point shifts less than 1% of range for a 50 F (28 C) ambient temperature change.

C. The pressure switch shall use an EPDM sensor material and should handle a maximum temperature of 250 degrees F.

D. The pressure switch shall be enclosed in Type 1 Enclosure and shall be made of Zinc plated steel with bright chromate finish.

E. The pressure switch should be surface mounted with two screws through clearance holes, or mounted by pressure connection.

F. The pressure switch shall have electrical rating of 20 A at 480 VAC

G. Manufacturers
   1. United electric 25 Series Model 25A1F4A pressure switch.
   2. Approved equal.

2.18 PRESSURE GAUGE

A. The pressure shall be solid front and hinged blow-out back style with elastomer compensating diaphragm on the inside of the hinged blow-out back.

B. The pressure gauge accuracy shall be 0.5% full scale to ASME B40.1 standard (Grade 2A)

C. The pressure gauge case and blow-out back shall be made of molded fiberglass reinforced thermoplastic and should be fire retardant and impact resistant

D. The pressure gauge lens shall be 4 mm thick laminated safety glass with lens rind made of molded fiberglass reinforced thermoplastic.

E. The fillable liquid used for the pressure gauge shall be glycerin.

F. The Stem and socket connections shall be made of 316 Stainless steel.

G. Manufacturers
   1. McDaniel MPB-S Pressure gauge.
   2. Approved equal.

PART 3 – EXECUTION

3.01 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner's Representative changes required to resolve interferences.

3.02 IDENTIFICATION PLATES AND CODING

A. All components provided under this section, both field and rack mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Rack mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

B. The Contractor shall attach nametags to control devices with screws, bolts, or wire leader to create a permanent bond.

3.03 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.04 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.05 INSTRUMENT PROCESS CONNECTIONS

A. The Contractor shall complete all necessary connections to process equipment, control panels, and instruments as required to meet the intent of the drawings. All vents and drains from instrument process piping shall be routed to the proper vent headers or sewers as required for environmental reasons or as provided for in the job specifications and drawings.

B. Over range limit, maximum working pressure and static pressure limits shall not be exceeded to prevent damage to the transmitter. The Manufacturer shall specify all transmitters and measuring elements to be compatible with the pressure and temperature ranges of process parameters.

C. Process temperature limit, ambient temperature limit and storage temperature limit shall not be exceeded in any installation. The Manufacturer shall ensure the installation provides affordable protection to the instrument devices.

3.06 INSTRUMENT SETUP/PROGRAMMING

A. The contractor shall setup and program all instrumentation. As necessary, the Contractor shall have the Manufacturer's Representative on-site to program or setup any instrumentation, and ensure that no warranties are voided.

B. Copies of all software, programs, or equipment setup logs shall be given to the Owner prior to completion of the project. This information shall be made available to the Owner or Owner's Representative upon request at any time during construction or check-out of equipment.

3.07 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.08 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.09 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 40 91 16.29

MAGNETIC FLOW METERS

SECTION 40 91 16.29

MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all hardware, conduit, wiring, spare parts, accessories, and appurtenances as herein specified, as recommended by the manufacturers and as shown on the Drawings necessary to complete installation.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports or independent support framing, secured together, and anchored in place.

F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

G. Coordinate signal requirements with MBR System Supplier.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 91 00 Process Instrumentals

B. Section 45 50 00 Membrane Bioreactor (MBR) System

1.3 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:

1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.

2. A complete set of submittal information in PDF and MSWord format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.4 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting and installation information, electrical connection information, calibration instructions, maintenance information, and a trouble shooting guide.

PART 2 - PRODUCTS

2.1 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a stainless steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes. Ultrasonic electrode cleaning shall not be acceptable.

D. Grounding rings shall be provided for all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65□C. Meterand transmitter housings shall meet NEMA 4X requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and

transmitter housings shall be selected with rating to meet the requirements for use in those areas. Non-metallic transmitter housings shall not be acceptable.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of 10^9-10^{11} ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.5 percent of rate over the flow velocity range of 1.0 to 30.0 feet per second. Repeatability shall be 0.1 percent of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than five uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°Celcius. Power supply shall be 115 VAC, 60 Hertzz.

M. Flow tubes shall be 150-pound flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be mounted integrally on flow tube, wall, or two-inch pipe mounted as shown in the Drawings or as specified.

N. Magnetic flow meter systems shall be as manufactured by Rosemount or approved equivalent.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

B. Refer to the specifications for further requirements.

3.2 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner and Engineer changes required to resolve interferences.

3.3 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.4 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.5 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.6 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies.

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.7 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 40 92 33

REG-U-FLO® FLOW CONTROL DEVICE

SECTION 40 92 33

REG-U-FLO® FLOW CONTROL DEVICE

PART 1 – GENERAL

1.01 SCOPE

A. Work described in this section includes furnishing all labor, equipment, materials, tools, and incidentals required for a complete and operable installation of the flow control unit as shown on the drawings and specified herein. The manufacturer shall supply the equipment and the general contractor shall install the equipment.

1.02 DESIGN REQUIREMENTS

A. The flow control unit shall be supplied by a single supplier.

B. The flow control unit to be furnished hereunder shall be made by a manufacturer regularly engaged in such work and who has furnished similar installations and had them in successful and continuous operation for a minimum period of ten years.

C. Data on performance testing, service history, and operation of existing installations using the submitted equipment shall be made available to the Engineer, upon request, for use in determining that the flow control unit offered meets the intent of the contract, performance requirements, and criteria stated in these specifications.

D. The flow control unit shall be designed utilizing Computational Fluid Dynamics (CFD) and field data to verify its flow regime, head loss, and grit removal characteristics. Upon request, data on the computation methods used and generic simulation results shall be made available to the engineer.

1.03 SUBMITTALS AND OPERATION AND MAINTENANCE MANUALS

A. Submittals shall be provided in accordance with the General Conditions and shall include the following:
   1. Manufacturer's catalog data and descriptive literature including equipment weights and performance data.
   2. General arrangement and dimensional drawings of the grit removal system.
   3. Written recommended procedures for job site storage, handling, and installation of the equipment.

B. Operation and maintenance manuals shall be provided at the completion of the job and in accordance with the General Conditions. The manuals shall include the following data:
   1. Alignment, adjustment, and repair instructions.
   2. MANUFACTURER'S installation instructions.
   3. Assembly diagrams.
   4. Troubleshooting guide.

1.04 QUALITY ASSURANCE

A. WARRANTY:
   1. Any product that proves defective in material, workmanship, or design within twelve (12) months after substantial completion shall be modified, repaired, or replaced, at Owner's decision.

B. CERTIFICATE OF COMPLIANCE:
   1. The MANUFACTURER shall warrant that the flow control unit to be supplied shall be manufactured in strict compliance with the Contract Specifications.

C. The system shall be furnished by a MANUFACTURER who is ISO 9001:2008 and 14001 Certified.

D. MANUFACTURER shall be successful in the experience of manufacture, operation, and servicing of flow control units of type, size, quality, performance, and reliability equal to that specified for a period of not less than ten (10) years. The MANUFACTURER shall submit evidence of experience having supplied a minimum of ten (10) installations in North America of similar size to the proposed system.

E. In the absence of verifiable experience, the MANUFACTURER shall be required to provide an extended warranty and subsequent Performance Bond for the same number of years that the MANUFACTURER was found lacking in experience from the specified ten (10) year period. The performance bond shall commence with acceptance of the equipment and time described herein and beyond the standard warranty period.

F. If equipment other than that shown on the Drawings is submitted to the Engineer for consideration as an equal, it shall be the responsibility of the MANUFACTURER requesting approval to submit with the request a revised design and layout of the mechanical equipment acceptable to the ENGINEER. Revised drawings shall show the proposed location of the alternate unit and area required for withdrawal space of replacement or serviceable components. This drawing shall also show clearances of adjacent equipment and service area required by that equipment.

   Changes in architectural, structural, electrical, mechanical, and plumbing requirements for the alternate shall be the responsibility of the Manufacturer requesting approval. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the MANUFACTURER and not the OWNER.

1.05 MANUFACTURER

A. The flow control valve shall be manufactured by Hydro International, Hillsboro, OR. 2925 NW Aloclek Drive #140, Hillsboro, Oregon, 97124, telephone 503-615-8130. Being named or bidding as an equal does not relieve the manufacturer of meeting these specifications.

B. Alternate manufacturers shall require the engineer's written approval 15 days prior to bid opening.

PART 2––PRODUCTS

2.01 FLOW CONTROL UNIT

A. DESIGN DATA:

1.	Number of Units:	As shown on drawings.
2.	Size:	4 Inches.
3.	Configuration:	SXV.
4.	Flow/Unit:	150 gpm with 8.268 feet head loss.
5.	Influent Connection:	4 Inch flanged pipe.
6.	Underflow Connection:	4 Inch flanged pipe.
7.	Underflow Layout:	Gravity.
8.	Materials of Construction:	304 SS.

B. OPERATION:

1. The flow control unit shall be designed to regulate the flow between the grit removal unit and the grit dewatering container.
2. All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials.

C. CONSTRUCTION:

1. The flow control valve shall be fabricated from 304 stainless steel. The vessel walls shall be ¼-inch thick.
2. All flanges shall conform to ANSI B16.1 bolt patterns.

2.02 MATERIALS AND FINISHES

A. MATERIALS:

1. All stainless steel used for the fabrication of the equipment shall conform to the following standards:

Plate and Sheet:	ASTM A 167
	ASTM A 240
Bar:	ASTM A 276
	ASTM A 479
Tube:	ASTM A 312

B. EXTERIOR SURFACES FINSHES:

1. All surfaces shall be free of sharp edges, weld spatter, and residue. All welds shall be ground smooth.
2. All stainless steel surfaces shall be acid washed.

PART 3––EXECUTION

3.01 DELIVERY AND INSTALLATION

A. The equipment and material shall be shipped complete except where partial disassembly is required by transportation regulations or for protection of components.

B. The CONTRACTOR shall inspect equipment prior to unloading and notify the MANUFACTURER of any damage to equipment within 5 days to effect proper remedial action.

C. The CONTRACTOR shall unload, store, and safeguard equipment, materials, and spare parts in accordance with MANUFACTURER's recommendations.

D. Install unit according to Manufacturer's recommendations and as shown on drawings.

3.02 START-UP, TRAINING, AND MANUFACTURER'S SERVICES

A. A factory trained representative for the equipment specified herein shall be present at the jobsite or classroom designated by the Owner for a maximum of one (1) 8-hour man-days (one (1) visit) for startup, functional testing, and operator instructions; travel time excluded. A minimum of 20 days' notice is required to schedule manufacturer's services. The trained representative shall verify installation prior to start-up and functional testing. Contractor shall address deficiencies or representative suggestions prior to start-up and functional testing.

3.03 FUNCTIONAL TESTING

A. Prior to plant startup, all equipment shall be inspected for proper alignment, operation, connection, and satisfactory operation by means of a functional test. The General Contractor shall notify the MANUFACTURER of any inabilities to perform functional testing prior to operator training.

3.04 MANUFACTURER'S CERTIFICATE(S)

A. Provide MANUFACTURER'S certificate of installation and commissioning following functional testing and start-up.

END OF SECTION

INDEX TO

SECTION 40 95 13

MBR CONTROL PANEL

SECTION 40 95 13

MBR CONTROL PANEL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following.

Section	Description
45 50 00	Membrane Bioreactor
40 95 20	MBR SCADA Hardware and Software

1.02 REFERENCES

A. Standards referenced in this section are listed below:

1. National Electrical Code (NEC): NFPA 70.

2. National Electrical Manufacturer's Association (NEMA):

a. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volt Maximum).

b. NEMA ICS 6 - Enclosures for Industrial Control and Systems.

3. Underwriters Laboratories Inc. (UL):

a. UL 50 - Enclosures for Electrical Equipment.

b. UL 508 - Industrial Control Equipment.

c. UL 508A - Standard for Industrial Control Panels.

1.03 SCOPE

A. This Section specifies the hardware requirements for the MBR control panel.

B. The control panel, as specified herein, shall be furnished by the same System Integrator as outlined in 40 95 20 MBR SCADA Software and Hardware.

C. The control panel provider shall be responsible for the following:

A. Design of the MBR system control panel.

B. Development of the MBR system control panel submittal documentation and drawing set.

C. Fabrication of the MBR system control panel.

D. Delivery of the MBR system control panel in packaging designed to prevent physical damage.

1.04 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by Underwriters Laboratories to assemble and certify UL-labeled control panels:

1. All components and equipment shall comply with requirements to meet UL508 listing.

2. All control panels shall be UL 508A labeled unless otherwise allowed for in the Contract Documents.

1.05 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information shall fully describe the hardware, software, and accessories included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

B. Submit the following control panel shop drawings in a single package:

1. Layout diagrams for all control panels and enclosures. Include panel elevations (front, side, interior), and sizing. Panel front elevations shall be of sufficient scale to allow all engraved nameplates and inscriptions to be legible without the use of schedules.

2. Wiring diagrams for all control panels. Diagrams shall be complete electrical wiring diagrams showing all components and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc. All wires and terminals shall be numbered on the diagrams, and line cross references shall be labeled. Include wiring interface to the SCADA controllers where applicable. Include on these drawings, a tag number to identify each component, referenced to a component identification list.

3. Power requirements and heat dissipation summary for all control panels. Power requirements shall state required voltages, currents, and phase(s). Heat dissipations shall be maximums and shall be given in Btu/hr. Summary shall be supplemented with calculations.

1.06 WARRANTY

A. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the RFP and the Contract Documents. The warranty duration shall be 12 months beyond Final Acceptance. All hardware components that are part of the completed system shall be covered by the warranty. The control panel supplier shall coordinate any warranties provided by third party suppliers.

PART 2 - PRODUCTS

2.01 CABINET

A. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common keyed locks.

B. Cabinets and panels located outdoors or in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction. Cabinets located in chlorine storage/feed areas shall be of nonmetallic, FRP construction, rated NEMA 4X.

C. Cabinets and panels located indoors within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

D. Cabinets and panels shall have doors on the front and shall be designed for front access. All cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.

E. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

F. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman, Rittal, Saginaw, or approved equal.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Control and data acquisition associated with site equipment shall be performed by a Programmable Logic Controller (PLC).

B. Each PLC and I/O rack shall be equipped with its own regulated power supply module energized from a standard, commercial 120 VAC 60 Hz, single phase source provided by the Uninterruptible Power Supply. Any power transformation, rectification, regulation, or other conditioning necessary shall be provided as part of the unit's power supply package. The module shall have sufficient capability to handle the power requirements for all the PLC components and I/O points, including the required, installed spare I/O capacity.

C. The PLC shall be Allen-Bradley CompactLogix 1769-L32E or 1769-L35E. A minimum of 768 KB of user memory shall be installed. The actual amount of memory

supplied shall be sufficient to provide 20% unused capacity when the entire PLC program, as provided, is loaded and running. Provide industrial Compact Flash module to maintain memory integrity of the PLC program and eliminate the need for downloading system programs from a host computer following temporary (short-term) power failures. PLC shall be capable of executing ladder logic, function blocks, structured text, and sequential flow chart logic.

D. All I/O modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All terminals shall be provided with unique identification. All I/O modules shall be Allen-Bradley 1769 series.

E. The PLC shall communicate with the MBR SCADA system over an Ethernet network.

F. I/O count shall be as required to implement the functional requirements of the system.

1. Size the I/O chassis for the required I/O cards plus the greater of 1 spare module or 10% additional spare I/O of each type.

2. If necessary, use expansion chassis to accommodate these requirements.

2.03 NETWORK SWITCHES AND MODEMS

A. As required to provide Owner with a complete and fully functional system.

2.04 MISCELLANEOUS REQUIREMENTS

A. All material shall be new, unused and actively marketed for new applications when shipped for configuration.

B. Provide ten percent (rounded up) spare fuses (minimum of 10) of each type and rating supplied.

PART 3 - EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment, and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top.

2. Thermostatically controlled, low noise internal air blowers (initial set point 75 °F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

E. Wiring shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 26 of the specifications.

F. Separate terminal strips shall be provided for each type of power and signal used within each cabinet.

G. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

H. A copper 120 VAC ground bus shall be installed in each cabinet, and shall be connected to the building power ground. A separate, isolated copper ground bus shall be installed in each cabinet for the logic (24 VDC) ground. Both ground buses shall be clearly labeled as to voltage and function.

I. All interior panel wiring shall be labeled and uniquely identified.

J. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit within and distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

K. The power entrance to the panel shall be provided with a surge protection device.

L. The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:

1. Solenoid valves

2. Electrically actuated valves

3. Instruments connected to the control panel.

M. Door mounted HOA switches shall be provided for all solenoid and non-modulating valves.

N. Fuse holders shall be indicating type.

O. A panel mounted UPS shall be included in each PLC cabinet. The UPS shall be sized to provide at least 30 minutes of run time for the PLC. The UPS shall also power any door mounted operator interface if included.

P. Intrinsic safety barriers shall be provided for all equipment signals originating in a hazardous area.

Q. Enclosures with any dimension larger than 36 inches shall be provided with fluorescent service lights and 120 VAC duplex receptacles for service equipment. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

END OF SECTION

INDEX TO

SECTION 40 95 20

MBR SCADA SOFTWARE AND HARDWARE

SECTION 40 95 20

MBR SCADA SOFTWARE AND HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor
40 95 13	MBR Control Panel

1.02 REFERENCES

A. Standards referenced in this section are listed below:

1. Underwriters Laboratories Inc. (UL)

1.03 DEFINITIONS

A. Operator Interface Terminal – A terminal usually embedded in a control panel that allows the operator to view and modify control system parameters. Operator Interface Terminals are not capable of running commercially available software.

B. Operator Workstation – A terminal that runs a commercially available operating system such as Windows. An Operator Station will usually execute the SCADA software. Operator Stations are usually desktop mounted personal computers. However, they may be computers that are designed to be embedded in the doors of control panels.

C. SCADA – Supervisory Control and Data Acquisition. A SCADA System is a computer (typically a personnel computer), or a group of computers and servers running a software dedicated for SCADA purposes. This SCADA software can exchange over industrial networks, with PLC's, VFD's, and other industrial devices. Typically, the SCADA software will allow for trending, graphic display, alarm tracking, and reporting of data.

D. SCADA System Provider – A company that takes a commercially available SCADA software package, and then develops a project specific application. This company will typically supply hardware for the SCADA software and application to operate on.

A.

1.04 SCOPE

A. This Section specifies the SCADA software and hardware for control of the MBR system and the supporting or accessory functions at the plant disinfection system, effluent flow meter (including but not limited to influent flow meter, screens, plant drain, centrifuge, effluent pump station, and effluent spray application).

B. The SCADA system, as specified herein, shall be furnished by the same System Integrator as outlined in 40 95 13 MBR Control Panel.

C. The SCADA System Provider shall be responsible for the following:

1. Supply of the MBR system SCADA and Operator Workstation (the plant workstation).

2. Coordination with all panel suppliers to insure proper data transfer between the MBR operator station and control panels.

3. Delivery of Operator Workstation and SCADA software in packaging designed to prevent damage from static electricity and physical damage.

4. Integration of all equipment process items into the overall plant SCADA.

1.05 QUALITY ASSURANCE

A. All electrical components, devices, and accessories shall be UL listed.

1.06 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information shall fully describe the hardware, software, and accessories included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals shall include, but not be limited to the following:

1. Hardware Product Information Submittal

2. Software Product Information Submittal

a. Software License information shall be submitted for each software or program in the system, indicating the number of licenses provided for each type of program or software.

1.07 OPERATION AND MAINTENANCE MANUALS

A. The SCADA System Provider shall supply O&M manuals for all equipment and software provided. The manuals shall be developed for an electronic technician audience. A manual, or manuals, shall be furnished for all deliverable hardware,

including OEM equipment. Manuals for OEM equipment shall contain original printed materials, not copies, and may be in the manufacturer's original format.

B. The SCADA System Provider shall supply a Graphical Interface Users' Manual. The manual shall be developed for an operations technician audience.

1. The Graphical Interface Users' Manual shall describe the configuration and functions of the provided Human Machine Interface. The manual shall describe in detail the operator interface operator interaction sequences. The following shall be provided, as a minimum:

a. Summary description of all major functions.

b. Presentation of data on displays.

c. Description of how the system and equipment react to situations such as heavy alarming, loss of communication links, heavy operator interaction, and loss of power and restoration of power.

d. Description of every message and alarm that the system is capable of outputting, and an explanation of what the message indicates.

C. O&M support materials shall include:

1. Program Media:

a. The SCADA System Provider shall furnish complete sets of program media documentation. These documents shall include source of all programs written by the SCADA System Provider specifically for the proposed system. This includes, SCADA applications, HMI scripting, and objects of all programs necessary for the operation and maintenance of the systems programs. If any changes are made to programs during commissioning, the SCADA System Provider shall provide, within 10 days, corrected copies of source, object, and system media.

2. Program Listings:

a. Each program listing shall include revision information. Each time a change is made in the listing, its revision level shall be documented by the party making the change. Program listings will include all in-program comments and documentation, and must be clearly understandable by programmers familiar with the language used. Undocumented code is not acceptable.

3. Software Licenses:

a. Each software package shall be provided with documented serial numbers and verification of licenses in Owner's name.

4. Remote Access Procedure:

a. The Remote Access Procedure documentation shall describe configuration of remote access software including all applicable phone numbers, IP Addresses, usernames and passwords.

D. Final manuals and documentation shall be provided in an electronic format on media compatible with the optical drives supplied with system. Electronic documents shall be provided in both the native application used for creating the documents (MS Word, AutoCAD, etc.) and the Adobe PDF format.

1.08 WARRANTY

A. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the Agreement and this product manual. The warranty duration shall be 12 months beyond Final Acceptance. All software and hardware components that are part of the completed system shall be covered by the warranty. The SCADA System Provider shall coordinate any warranties provided by third party suppliers.

PART 2 - PRODUCTS

2.01 OPERATOR WORKSTATION

A. The requirements defined in this subsection apply to the computer-based components of the SCADA System Provider's proposed system.

1. All workstations shall be from a single manufacturer and be from the same "family" or product line. All computer equipment shall be from the equipment manufacturer's standard offering and shall not be specifically built nor require major modifications in order to meet the requirements set forth in this Specification.

2. The MBR SCADA system shall use an Ethernet network as the preferred peer-to-peer network.

B. Minimum Hardware Requirements:

1. Workstations shall be Dell Precision or equivalent with equal or higher quality. The minimum workstation hardware requirements are as follows:

a. 3.00 Ghz Intel® Xeon 4 processors w/2 MB Cache.

b. 2GB DDR3 SDRAM, ECC.

c. Dell 19-inch flat panel monitor.

d. 250 GB Hard Drive, SATA, 7200 RPM.

e. 16X DVD+/-RW Optical Drive.

f. Graphics card suitable to handle the graphics of the SCADA application.

g. Dell QuietKey keyboard.

h. Dell USB Optical Mouse.

2.02 UNINTERRUPTIBLE POWER SUPPLIES

A. Uninterruptible Power Supplies (UPS) will be provided for all workstations and network switches in the project. As a general rule, provide a dedicated UPS for each workstation. The UPS system shall be able to run on Utility or generator power without any disruption in service. The UPS shall also be able to absorb the transients generated by ATS changeover.

2.03 SCADA SOFTWARE

A. The requirements defined in this subsection apply to SCADA software and configuration of the proposed control system.

B. The SCADA software shall be capable of communicating to PLCs connected to the network, remote PLCs, I/O servers, and other devices on the network. The SCADA software shall have the following communications capabilities:

1. Diagnostic alarms shall be provided with the system that will automatically notify the operator of the failure of any communications path.

2. A package of communication drivers that shall include the following as a minimum:

a. Ethernet (TCP/IP).

b. EthernetIP.

C. Security features shall be fully integrated to allow only users with appropriate security levels access to individual parts of the system. The SCADA software shall have the following:

1. Passwords hidden in both the configuration and runtime environments to ensure that other personnel cannot access another account.

2. Monitoring and logging of each control action of each user. This shall include all operator control actions, including system log-in and log-out. The sequence of actions shall be viewable within the SCADA package and also exported to an external open file format (e.g. txt, csv) for later analysis.

3. Automatically log out a user after an adjustable time period. Logging out a user will only cause the system shall revert to a view-only security status. Logging out will not shutdown the system.

4. A minimum of four privilege levels. The software shall ensure that a user has access to all tasks for his privilege level. If the user does not have the correct privilege for a task, a message will indicate insufficient privilege.

5. Assign each graphic object to a plant area, define the privilege level, define whether operator input is enabled or disabled, and if the object will be interactive or not based on the operator's current privilege levels within the plant area.

D. The SCADA software shall have the following graphical display features:

1. Capable of displaying images from 3rd party packages for use within the SCADA displays.

2. Capable of pop-up windows for trends, loops, device status, and device control by clicking on hot spots or objects on the main graphics page.

3. Ability to allow the user to navigate around the graphics system utilizing a variety of navigation methods.

4. Hot Key links to specific graphics pages from the keyboard.

5. Navigation menus allowing access to system set-points, trends, logs, and performance summary pages from any page.

6. Configured with "hot spots," where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

E. The SCADA software shall monitor and display all analog, discrete, and calculated process values.

1. Historical data logging functionality shall be provided:

a. All analog and calculated values shall be logged to a local database with value, time and date labels.

b. Data logged to disk shall be viewable while the system is online or offline without interrupting data collection.

c. Ability to export historical data logs to an external open file format (e.g. txt, csv) for later analysis shall be provided.

F. The SCADA software shall monitor and display all process alarm conditions.

1. Alarm display shall have the following:

a. Alarms shall be configurable in multiple levels. The color of the text of the alarm message shall indicate priority. Text color shall be configurable by engineers.

b. Provided with a standard alarm display page. The alarm page shall allow for scrolling of alarms, and acknowledgment of individual alarms or all alarms on the page.

c. Possibility to display the following information for each alarm as it appears on an alarm display page:

i. Alarm Tag Name.

ii. Alarm Description.

iii. Value of the Variable.

iv. Trip point.

v. Alarm Status: Disabled, Acknowledged, Unacknowledged.

vi. Alarm Category or Priority.

vii. Time & Date.

viii. Category.

d. A mechanism for operators to dynamically define filtering of alarms by alarm name, tag name, date /time range, state or type.

2. Alarm logging functionality shall be provided:

a. The alarms shall be able to be logged to a local database with alarm text, time and date labels.

b. Alarms that are logged to disk shall be viewable while the system is online or offline without interrupting data collection.

c. Ability to export alarm logs to an external open file format (e.g. txt, csv) for later analysis shall be provided.

G. The software shall provide the following trending functionality.

1. The software shall be capable of displaying historical trend information over a user configurable time period.

2. Every analog tag defined in the system configuration shall be available for trending.

3. The software shall have the following in its native functionality:

a. Line graphs with time on a linear, continuous horizontal or vertical axis and the trended variable on the vertical or horizontal axis.

b. Where more than one variable is displayed on the same graph, the pen color of each variable and associated information shall be displayed in a different color.

c. Each trend graph shall be capable of displaying a minimum of eight trend pens.

d. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independent to each other pen displayed on a page.

e. Include the capability to pan backward and forward within a selected time range to read the exact value of any displayed variable, by selecting a point on the graph or chart. The system shall display historical information as far back in time as desired.

f. The trend display shall be dynamic, scrolling through time, with the capability to stop the automatic scrolling of the trend for detailed analysis of a point in history.

g. The trend display shall have a minimum of two slide wires that can be moved over the page. The slide wires will provide indication of the date, time, and value at the intersection of the slide wire and the trend point.

h. The software shall provide "zoom" and "pan" facilities for both the trended variable range and the time axis range.

i. The software shall make available trending data from the historical database for export to disk files or external databases. Data shall be exported to csv or txt formatted files.

H. SCADA software shall be Wonderware Intouch.

2.04 OPERATOR WORKSTATION SOFTWARE

A. The MBR Operator Workstation software package shall support dual core and multi-processor CPU's.

B. As a minimum, the SCADA software shall run development and runtime implementations on the following Microsoft operating systems:

1. Windows 7 Professional.

C. The specified SCADA functionality shall have communications drivers, graphics capabilities, data reporting, historical storage, trend and alarm displays, and the development environment offered as a single integrated software package or suite of packages. Additionally, software will be supplied to enhance functionality of the software package:

1. Word Processing and Spreadsheets: Microsoft Office 2007 Basic.

2.05 MISCELLANEOUS REQUIREMENTS

A. All material shall be new, unused and actively marketed for new applications when shipped for configuration. All acquired hardware and software shall be registered to "The Owner," as user, and "Owner's Company's Name," as the organization.

B. Provide "mock-up" of screen views to Engineer for approval.

C. Include all treatment plant and disposal equipment in SCADA system.

END OF SECTION

SECTION 41 22 13

CRANES AND HOISTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions (if included), and Division 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Monorail and Hoist
   1. Unless otherwise noted, this section includes furnishing and installing the overhead hoisting equipment, controls, trolleys and supporting monorails in accordance with the drawings and specifications for the operation shown on the drawings and specified herein.
   2. All work performed under this section shall comply and be in accordance with trade approved practices and manufacturer's recommendations, including Safety Standards ASME / ANSI B30.16 "Overhead Hoists (Underhung)".

1.3 QUALITY ASSURANCE

A. Standards - The overhead electric chain hoists shall conform to the following standards:
   1. Hoist Manufacturer's Institute (HMI)
   2. American National Standards Institute (ANSI)
   3. National Electrical Code (NEC)
   4. American Society of Mechanical Engineers (ASME)
   5. Comply with CSA Standards (when necessary to do so)
   6. Lifetime warranty against defective material and workmanship

1.4 SUBMITTALS

A. In accordance with Division 1, submit the following:
   1. Manufacturer's Literature: Submit cut sheets and all necessary information to enable evaluation of product quality and performance and fulfillment of the requirements herein.
   2. Complete list of equipment with the manufacturer's name and model numbers.
   3. Shop drawings of crane, runway beam, rails, and associated supports.
   4. Crane cross-section sketches with all pertinent dimensions.
   5. Design loads.
   6. Manufacturer's painting and galvanizing system for cranes and monorails.

PART 2 PRODUCTS

2.1 HOIST - GENERAL

A. Electric Hoists - All electric hoists shall be as indicated on the drawings or as specified herein. All hoist motors, shall comply with the requirements as indicated in section 2.3 - Electrical Equipment.

B. Hoist shall meet the safety standard ASME B30.16 for overhead hoist (underhung).

C. Hoist shall meet the performance standard ASME HST-1, electric chain hoist.

D. Hoist shall be considered suitable for H3 duty classification.

E. Steel components and accessories shall be made with steel complying with ASTM A36 or A992. All steel used in the exterior monorail systems shall be primed and painted as specified herein.

F. All bolted field connections shall be made with A325 high-strength bolts installed as slip-critical.

2.2 HOIST – PERFORMANCE

A. Provide one underhung Monorail and Hoist above the Membrane Bioreactor (MBR) Basin.
   1. 4 ton capacity electric chain hoist.
   2. See Structural Drawings for monorail location, layout, spans and cantilevers.
   3. The hoist shall be an electric chain hoist with motorized trolley and bottom safety hook, suitable for use with monorail.
      a. Single speed hoists: 16 fpm
      b. Trolley Speed: 35 fpm
      c. Lift Distance: 26 feet
      d. 460V-3PH-60Hz
      e. 115V AC control voltage
      f. Cross mounted configuration

B. Acceptable Hoist Manufacturers:
   1. Coffing Hoists.
   2. Harrington Hoists.
   3. Or approved equal

2.3 SPECIAL FEATURES

A. Provide hoist system with the following:
   1. Remote control system with (1) received and (2) transmitters
   2. Mainline contactor
   3. Horn (activated when trolley moves)
   4. NEMA 3R hoist enclosure
   5. Push Button Pendant Station:
      a. NEMA-4X
      b. Stop/start buttons
      c. 2-position selector (local/remote)

d. 1-speed hoist buttons (up/down)
e. 1-speed trolley buttons (right/left)

6. Zinc plated load chain
7. Zinc plated load hook
8. Zinc plated load sheaves and chain guides
9. Zing plated hoist electric brake components
10. Factory applied epoxy paint (white)
11. Chain container with factory applied epoxy paint (white)
12. Weather resistant nylon cover

2.4 MECHANICAL

A. The hoist shall be equipped with alloy steel load chain, heat treated for optimum strength and wear resistance, sized for the specified load. The lower hook block shall be of the swivel type. All hooks shall have a spring operated latch kit which is notched, in order to allow a positive engagement with the hook tip.

B. The hoist shall be equipped with a chain end stop assembly as an added feature to reduce the possibility of chain running out of hoist. A chain guide shall be provided to resist chain jamming and to maintain chain alignment with the load sheave. Double and triple reeved units shall have the bottom blocks equipped with grease fittings.

C. All hoist gearing shall be helical and spur type, precision machined of alloy steel and operating in an oil bath for longer, quieter, performance. The first stage minimum must be helical gearing.

D. All bearings shall be heavy duty, anti-friction type. All gears shall operate in an oil bath in sealed housings providing positive splash lubrication for gears and bearings. The load sheave or lift wheel shall have a minimum of five pockets.

E. The hoist motor brake shall be of the heavy duty, three post type, magnetically operated, multiple disc, direct acting, AC type. Brake shall be spring activated and equally effective in both directions of motor rotation. It shall be of sufficient size to stop and hold the rated capacity of the hoist. The brake shall automatically set when current is not flowing to the motor.

F. A mechanical load brake shall be provided in addition to the hoist motor brake. The mechanical load brake shall be of the Weston type and multiple discs, to control load lowering and prevent drift.

G. The hoist shall be equipped with a factory calibrated, non-adjustable, friction type, overload clutch that protects the hoist, overhead support structure and hoist operator from damaging overloads, chain jamming and reverse phasing.

H. Adjustable upper and lower limit switches shall be included as standard equipment with the hoist. The limit switch traveling nuts shall be of brass and the shaft shall be of stainless steel to prevent corrosion and to insure long life.

I. The hoist's top suspension(s) shall be designed for easy replacement with the removal of socket head cap screws, eliminating the need to disassemble the housings.

J. The hoist shall be equipped with chain container unless otherwise noted in the specifications or drawings.

2.5 ELECTRICAL EQUIPMENT

A. Motors shall be NEMA Standard design for hoist duty service. High torque, H3 duty class (on single speed motors) with class F insulation, rated on the basis of 40 degrees Celsius ambient temperature.

B. Single phase hoist motors shall be dual voltage (115/230) as standard equipment. Three phase, single speed motors shall be dual voltage (230/460) as standard equipment. When required, optional 208 volt single speed and 575 volt single speed, single voltage motors shall be furnished at no additional cost. Optional single voltage, two speed motors shall be available when required for three phase applications.

C. Push button controls for all electrified portions of the hoisting system shall be continued in one common push button control pendant. Pendant shall be made from double insulated thermoplastic or equal material and rated NEMA-4X.

D. Connection wires on the control panels shall be numbered for ease of installation, maintenance and repair. Control transformers shall provide low voltage control circuit(s) as standard equipment (24 volts) for operator safety.

2.6 TROLLEYS

A. Trolleys shall be lug mounted for maximum headroom and rigidity when possible. They shall be plain, geared, or motorized. Hook type versions may be used for specific applications when required.

B. Trolleys shall have tapered, or flat tread wheels to match the beam or rail on to which they are installed. They shall have wrap around side plates to act as bumpers or safety lugs.

C. Trolley wheels shall be made from cast iron and are to include permanently lubricated and shielded ball bearings for long life and low maintenance.

D. Geared trolleys shall have an endless chain for horizontal travel that will extend to within three feet of the floor.

E. Trolleys voltages shall be equivalent to the hoist voltages specified herein.

PART 3 EXECUTION

3.1 INSTALLATION

A. The Contractor shall review the dimensions of the crane and hoist shop drawing submittals as well as the basin & roof shop drawings to ensure that the crane assembly fits properly within the specified location and that there are no operating interferences.

B. The Contractor shall install runway beams, rails, bridge crane, hoist, controls, and accessories as the building is being constructed. Mount crane plumb and square with surrounding structure.

C. Immediately after runway beams are installed, Hoist Supplier shall survey runway beams to ensure that erection tolerances meet requirements of the CMAA Specification Number 70. If adjustments are necessary, the Contractor shall re-position runway beams to ensure smooth operation of crane.

D. After crane system is installed, Hoist Supplier shall inspect the crane and perform start-up operations.
   1. Hoist supplier shall survey the runway beams and ASCE rails immediately after installation, and perform start-up operations after full system is installed.

E. Upon completion and before final acceptance, each hoist system shall be tested by an OSHA certified crane inspector per the South Carolina OSHA requirements. Written documentation of the tests shall be given to the Owner. Tests shall include, but are not limited to the following:
   1. Load test of 125% of rated capacity for critical positions along the full travel of the crane and hoist. Crane Supplier shall provide test weights.
   2. Hoisting and lowering.
   3. Trolley travel.
   4. Locking and safety devices.

END OF SECTION

INDEX TO

SECTION 43 21 21

SELF-PRIMING PUMPS

SECTION 43 21 21

SELF-PRIMING PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

45 50 00 Membrane Bioreactor

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of self-priming pump(s) described in this Specification.

B. Pump(s) shall be designed for continuous duty operation, to provide the transfer of fluid volumes as defined in the Pump Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. The manufacturer of the pump shall have a quality management system in place and shall be ISO 9001 certified.

B. The pump and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the pump(s) and associated accessories.

C. The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized pumps for a minimum of five years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the manufacturer's recommendations and the Contract Documents.

1.04 SUBMITTAL INFORMATION

A. Provide a complete sets of submittal information in PDF format. All pertinent information needed to fully describe the pump(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is

specified. Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer.
2. Type and Model.
3. Rotational speed.
4. Major component materials of construction.
5. Pump specification describing construction details.
6. Outline Dimension Drawing.
7. Installation Drawing.
8. Complete performance data showing capacity and power input.
9. Electrical Data that includes:
    a. Motor rating, Hp.
    b. Motor temperature rating.
    c. Motor full load rotational speed.
    d. Motor full load current.
    e. Motor locked rotor current.
10. Motor performance curves showing speed, efficiency, current, power, etc.

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include pump outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

PART 2 - PRODUCTS

2.01 PUMP DESIGN

A. Pumps must be designed to handle raw, screened, industrial waste.

B. Solids Handling Capability – When pumps are used for handling raw wastewater or activated sludge, all internal passages, impeller vanes, and recirculation ports shall pass a 2.5-inch spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not

be permitted. Upon request from the engineer or owner, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

C. Reprime Performance:

1. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

2. Pump must reprime the Maximum Repriming Lift shown in the Pump Schedule at the specified speed and impeller diameter while operating with only one-half of the liquid remaining in the pump casing. (Reprime lift is defined as the static height of the pump suction above the liquid.)

3. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition.

4. Upon request from the engineer or owner, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

D. Pump Schedules – Pumps shall be provided to meet to following conditions and duty points.

Pump Name	**Permeate Pump**
Number of Pumps	3
Fluid to be pumped	Water
Fluid Specific Gravity	1
Fluid Viscosity (cp)	1
Hazardous Location	No
VFD Controlled	Yes
Solids Concentration (mg/l)	5-10
Primary Duty Point	
Capacity(gpm)	212
Total Dynamic Head 1 (ft)	25

E. Pumps shall be end suction, single stage, horizontal frame mounted, vertical V-belt type base, self-priming centrifugal type.

F. Materials and Construction Features:

1. Pump casing – Casing shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:

a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.

b. Fill port coverplate, 3.5-inch diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for

safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.

c. Casing drain plug shall be at least 1.25-inch NPT to insure complete and rapid draining.

2. Coverplate – Coverplate shall be cast iron Class 30. Design must incorporate following maintenance features:

a. Retained by hand nuts for complete access to pump interior. Coverplate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wearplate or check valve without removing suction or discharge piping.

b. A replaceable wearplate secured to the coverplate by weld studs and nuts shall be AISI 1015 HRS.

c. In consideration for safety, a pressure relief valve shall be supplied in the coverplate. Relief valve shall open at 75-200 PSI.

d. Two O-rings of Buna-N material shall seal coverplate to pump casing.

e. Pusher bolt capability to assist in removal of coverplate. Pusher bolt threaded holes shall be sized to accept same retaining capscrews as used in rotating assembly.

f. Easy-grip handle shall be mounted to face of coverplate.

3. Rotating Assembly - A rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, sealplate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

a. Sealplate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.

i The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

ii The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.

iii Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

b. Impeller shall be ductile iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.

c. Shaft shall be AISI 4140 alloy steel unless otherwise specified by the engineer or owner, in which case AISI 17-4 pH stainless steel shall be supplied.

d. Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.

e. Shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be silicon carbide alloy. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the sealplate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton. Cage and spring to be AISI 316 stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings.

f. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

4. Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.

a. Clearances shall be maintained by external shimless coverplate adjustment, utilizing collar and adjusting screw design for incremental adjustment of clearances by hand. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings.

b. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above.

c. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

5. Suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the coverplate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.

6. Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports and meeting ANSI B16.1,Class 125. Each spool shall have one 1.25-inch NPT and one .25-inch NPT tapped hole with pipe plugs for mounting gauges or other equipment.

G. Motor

1. Motors shall be squirrel cage induction type, totally enclosed, fan cooled, rated for inverter duty (unless otherwise stated).

2. Motors shall be 460 volts, 60 Hz, 3 phase.

3. Motors shall have NEMA Class F insulation.

4. Motor performance shall conform to the requirements of NEMA MG1 Part 12 and shall be expressed as indicated in NEMA MG1-12.30.

5. Motors shall have a 1.15 service factor rating. The pump brake horsepower requirements shall not exceed the motor name plate horsepower under the operating conditions listed in the Pump Schedule.

6. Motors shall be premium efficiency type.

7. Inverter Duty:

a. All motors indicated in the Pump Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

ii Inverter grade, 1,600 volt, Class F insulation.

iii Service factor of 1.0 when operated from a VFD.

iv Meeting requirements of NEMA MG1 Part 31.

H. Manufacturer's Warranty:

1. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. All equipment, apparatus, and parts furnished shall be warranted for one year, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O-rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

3. Components failing to perform as specified by the engineer or owner, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the owner.

4. The warranty shall become effective upon substantial completion.

I. Manufacturers:

1. Gorman Rupp

2. Approved equal

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION

A. Contractor shall install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on pump piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required.

C. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

3.03 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed pump(s) for visual deficiencies.

B. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.04 PROTECTION

A. The contractor shall be responsible for provisions to protect the pumps and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

PART 1 SECTION 43 21 39

SOLIDS-HANDLING SUBMERSIBLE PUMPS

SECTION 43 21 39

SOLIDS-HANDLING SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

45 50 00 Membrane Bioreactor (MBR) System

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of submersible pump(s) described in this Specification.

B. Pump(s) shall be designed for continuous duty operation, to provide the transfer of fluid volumes as defined in the Pump Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. The manufacturer of the pump shall have a quality management system in place and shall be ISO 9001 certified.

B. The pump and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the pump(s) and associated accessories.

C. The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufactured who has been actively engaged in the supply of similarly sized pumps for a minimum of five years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the manufacturer's recommendations and the Contract Documents.

1.04 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information needed to fully describe the pump(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the

specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer.

2. Type and Model.

3. Rotational speed.

4. Major component materials of construction.

5. Pump specification describing construction details:

    a. Assembly drawing, nomenclature and material list.

    b. Type, manufacturer, model numbers, location and spacing of bearings.

    c. Impeller type, diameter, through-let dimensions, sphere size, number of vanes and identification number.

6. Setting plans shall include:

    a. Installation Drawing.

    b. Anchor bolt layout.

    c. Anchor bolt dimensions.

    d. Outline dimensions and weights of pumps, bases, motors, and control enclosures.

7. Complete motor performance data including:

    a. Rating, voltage/phase/frequency; design type; service factor; insulation class; motor pole number; actual rotation speed when combined with the specified pumps; current, power factor and active input power (KW) as a continuous function of shaft power from no load to at least 115% load; start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to full speed.

8. Warranty for the proposed equipment.

    a. The manufacturer shall indicate, by arrows to points on the Q/H curves, limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible, and shall be based on actual hydraulic and mechanical characteristics of the units

and shall meet the hydraulic performance requirements of the proposed system.

1.05 OPERATION ANDA MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include pump outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

1.06 SPARE PARTS AND TOOLS

A. Provide the following spare parts to the Owner, boxed, marked, and ready for long-term storage:

1. One set of mechanical seal assemblies for each size pump.

2. One complete set of gaskets for each size pump.

3. One complete set of bearings for each size pump.

PART 2 - PRODUCTS

2.01 PUMP DESIGN

A. The pump shall be capable of handling raw, unscreened sewage. The discharge elbow shall be permanently installed in the wet well or basin along with the discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for the purpose and no need for personnel to enter the pump well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a metal to metal watertight contact. No portion of the pump shall bear directly on the floor of the sump, and there shall be no more than one 90° bend allowed between the volute discharge flange and sump piping. Guide bars, which shall steer the pump into proper contact with the discharge elbow shall be non-adjustable and shall not bear the weight of the pump.

B. Pump Schedules: Pumps shall be provided to meet to following conditions and duty points.

Pump Name	Equalization Transfer Pump / RAS Pump
Number of Pumps	3
Fluid to Be Pumped	Screened, raw waste water and return activate sludge
Fluid Specific Gravity	1
Fluid Viscosity (cp)	110
Hazardous Location	No
VFD Controlled	Yes
Solids Concentration (mg/l)	8,000-10,000
Primary Duty Point	
Capacity 1 (gpm)	334
Total Dynamic Head 1 (ft)	20

C. Pumps shall be submersible, single-stage, centrifugal type, supplied with integral electric motor, discharge elbow, guide bar brackets and installation accessories. The pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 35 to 104 °F.

D. Materials and Construction Features

1. Pump casing and construction shall incorporate following features:

a. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel and/or brass, shall be protected by a factory-applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish or two-part epoxy on the exterior of the pump.

b. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton Rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit.

c. Rectangular cross sectioned gaskets that require specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

E. Cable entry

1. The cable entry seal design shall provide strain relief and preclude specific torque requirements to insure a watertight and

submersible seal. The cable entry shall consist of at least one elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. For units greater than 100 HP, cable entry shall incorporate dual grommets which shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2. The cable junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression-type terminals. The use of wire nuts or crimp-type connectors is not acceptable.

F. Bearings

1. The integrated pump/motor shaft shall rotate on two sealed and permanently lubricated bearings. External bearing lubrication ports, which allow bearing contamination and over-packing, will not be allowed. The upper bearing, providing for radial thrust, shall be a single row, roller or ball bearing. The lower bearing shall consist of one double row angular contact bearing for combined axial and radial loads. Minimum L_{10} bearing life shall be 50,000 hours at any usable portion of the pump curve.

G. Motor

1. Each pump shall be driven by a vertical, submersible squirrel cage induction motor, shell type NEMA B design, housed in a dry watertight chamber. The motor and the pump shall be produced by the same manufacturer.

2. The stator winding shall be insulated with moisture resistant Class H insulation, rated for a temperature of 180 °C. The stator shall be insulated using Class H monomer-free polyester resin, resulting in a winding fill factor of at least 95%. The stator shall be heat shrink fitted into the cast iron stator housing. The use of multiple step dip and bake type stator insulation process is not acceptable. The use of bolts, pins, screws, or other fastening devices used to locate or hold the stator and that penetrate the stator housing shall be rejected. The motor shall be designed for continuous duty, while handling pumped media of up to 104 °F. The motor shall be capable of withstanding at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

3. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with, and

supplemental to, external motor overload protection, and shall be connected to the motor control panel.

4. The motor service factor (combined effect of voltage, frequency, viscosity, and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for continuous operation in a 40 °C ambient environment and shall have a NEMA Class B maximum operating temperature rise of 80 °C. A motor performance curve shall be provided upon request, showing torque as a function of speed, and current, power factor, speed, input power in KW, and efficiency as a function of shaft power.

5. The motor shall be sized to be non-overloading when the pump is operated at any point on the pump performance characteristic curve. See Section 4.0 for application-specific motor performance requirements.

6. Motors shall be 460 volts, 60 Hz, 3 phase.

7. Motor performance shall conform to the requirements of NEMA MG1 Part 12 and shall be expressed as indicated in NEMA MG1-12.30.

8. Motors shall be premium efficiency type.

9. Inverter Duty:

    a. All motors indicated in the Pump Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

        i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

        ii Inverter grade, 1,600-volt, Class F insulation.

        iii Service factor of 1.0 when operated from a VFD.

        iv Meeting requirements of NEMA MG1 Part 31.

10. Shaft

    a. Pump and motor shaft shall be a solid continuous unit. The pump shaft is an extension of the motor shaft. Couplings and shafts incorporating sleeves shall not be acceptable. The pump shaft shall be completely isolated from the pumped liquid.

11. Motor Cables

a. Pump motor power cables installed shall be oil resistant chloroprene rubber jacketed, type SPC multi-conductor cable, suitable for submersible pump applications and heavy mechanical stresses. The power cable shall also be sized according to NEC and ICEA standards. The total length of each cable shall be a minimum of 40 feet long. Power cables shall each include a ground check conductor (see Sec. 5.14).

H. Hazardous Location Equipment (Explosion Proof Service)

1. In addition to the requirements listed above, for the installations which are considered to be in hazardous locations as defined by the National Electrical Code (NEC), only motors certified by Factory Mutual for use in such locations shall be used.

2. Specifically, the pump motors used shall be certified for use in all Class I, Divisions 1 and 2, Groups C and D, Class II, Divisions 1 and 2, Groups E, and G and Class III locations as outlined in Articles 500-502 inclusive of the NEC code.

I. Guide Bars And Brackets (Wet Well Mounted)

1. Guide bar(s) shall be provided for guiding the pump unit in raising and lowering. The guide bars shall not support any portion of the weight of the pump. The lower guide bar holders shall be integral with the discharge elbow. Guide cables shall not be considered equal to guide bars and will not be accepted. The pump unit shall be guided on the bars by a guide bracket which shall be an integral part of the pump.

2. The anchor bolts, upper guide bar brackets and cable holder shall be fabricated from 300 series stainless steel.

J. Lifting Cable And Fittings

1. Each pump shall be fitted with 20 feet (minimum) of AISI 304 stainless steel lifting chain (or stainless steel wire rope), with necessary fittings, capable of lifting the pump and motor.

K. Manufacturer's Warranty

1. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. All equipment, apparatus, and parts furnished shall be warranted for five years, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O-rings,

etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

3. Components failing to perform as specified by the engineer or owner, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the owner.

4. The warranty shall become effective at substantial completion.

L. Manufacturers

1. ABS

2. Wilo-EMU

3. Approved equivalent

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION

A. Contractor shall install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on pump piping. Install and secure all service lines as required.

3.03 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed pump(s) for visual deficiencies

B. Equipment shall be field tested as specified hereinafter. Field testing shall be composed of preliminary tests and acceptance tests. The Contractor shall provide the services of authorized equipment supplier's representatives to conduct all field tests.

C. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

D. Preliminary tests shall be run on all pumps, motors, and control systems to demonstrate that they are in proper working order.

3.04 ACCEPTANCE TESTS

A. Acceptance tests shall be run to demonstrate that the pumping units, motors and control system meet the following requirements:

1. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

2. All automatic and manual controls function in accordance with the specified requirements.

3. All drive equipment operates without being overloaded.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the pumps and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 44 05 13

GENERAL REQUIREMENTS FOR EQUIPMENT

SECTION 44 05 13

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of each individual equipment specification section.

B. Equipment Lists:

Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material required to be provided under this contract. The Contractor shall prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1.02 QUALITY ASSURANCE

A. Arrangement:

The arrangement of equipment shown on the drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment actually provided. No additional payment shall be made for such revisions and alterations.

B. References:

This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have

been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250)
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI S2.19	Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications

C. Unit Responsibility:

The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems as provided in paragraph 00710–2.04.

The Contractor shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual

specification requires the Contractor to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 44 05 13–C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment *even though the equipment may have been installed in the work.*

D. Balance:

Unless specified otherwise, for all machines 10 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

$$U_{per} = 6.015\frac{GW}{N}$$

Where:

U_{per} = permissible imbalance, ounce–inches, maximum

G = Balance quality grade, millimeters per second

W = Weight of the balanced assembly, pounds mass

N = Maximum operational speed, rpm

Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be *G* 2.5 (*G* = 2.5 mm/sec) or better in accordance with ANSI S2.19.

PART 2 – PRODUCTS

2.01 FLANGES AND PIPE THREADS

Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

A. Bearings

Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L–10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 ºC and shall be equipped with a filler pipe and an external level indicator gage.

All bearings accessible to touch, and located within seven feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures, shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 ºC or less for continuous operation at bearing rated load and a 50 ºC ambient temperature or shall be provided with appropriate shielding shall be provided that will prevent inadvertent human contact.

2.02 V–BELT ASSEMBLIES

Unless otherwise specified, V–belt assemblies shall be Dodge Dyna–V belts with matching Dyna–V sheaves and Dodge Taper–lock bushings, Wood's Ultra V–belts with matching Ultra–V sheaves and Wood's Sure–Grip bushings, or equal.

Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull–up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.

Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion proof equipment is specified.

2.03 PUMP SHAFT SEALS

A. General:

Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. For industrial wastewater service, or for fluids other than water or municipal wastewater, the recommendations of the seal manufacturer shall be

followed for selection of appropriate seals. Unless specified otherwise, stuffing boxes and mechanical seals shall conform to the requirements set forth in this paragraph.

B. Mechanical Seals:

Unless otherwise specified in the detailed pump specifications, mechanical seals shall be split mechanical seals requiring no field assembly, other than assembly around the shaft and insertion into the pump. They shall be self–aligning, and self–centering, single seals. They shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area (no shaft sleeve). Where the detailed specifications call for cartridge instead of split seals, all other requirements of this paragraph apply.

Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastelloy C, Elgiloy, or other Duplex SS selected for resistance to chloride attack. Rotary faces shall be silicon carbide or chrome oxide. Stationary faces shall be silicon carbide for solids bearing fluid service and carbon for clean water service. Elastomers shall be ethylene propylene or fluorocarbon. Mechanical seals shall be suitable for operation between full vacuum (0 psia) up to 200 percent of the maximum specified operating pressure, but in any event not less than 200 psig.

Seal chambers shall be provided with vented solids removal restriction bushings except for enclosed line shaft pumps where the seal barrier fluid is used for line shaft bearing lubrication. The bushing shall both control the amount of flushing water flow and restrict solids and gas accumulation from the seal face area.

Candidate seals include:

1. Chesterton 442 seals provided with Chesterton/SpiralTrac solids removal restriction bushings Version N or D, as recommended by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

2. AESSEAL RDS seals with Cyclops bushing.

3. John Crane 3710 seals with Type 24SL bushing.

Seals on pumps for contaminated water service (sludge, grit, wastewater, scum, reclaimed water, etc.) shall be drilled and tapped for connection of a clean water flushing supply.

Seals for all vertical pumps (whether column or volute type) shall be provided with a second flush connection. Vertical pumps shall have a vent valve attached to the mechanical seal to eliminate air from the seal chamber prior to pump start; start–up procedures shall include venting instructions; and for remotely started pumps, the vent system shall be automated. Where specified in the detailed specifications, permissive confirmation automatic vent systems shall be provided.

C. Shaft Packing:

Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Stuffing boxes shall be face attached. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified in paragraph 44 05 13–2.04.B for the applicable pump and operating conditions.

Unless otherwise specified, lantern rings shall be bronze or Teflon, packing shall be die–molded packing rings of non–asbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two–piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC–20. The impeller end of the packing on all but line shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

The section of each shaft or impeller hub that extends through or into the stuffing box shall be fitted with a replaceable stainless steel sleeve with a Brinell hardness of not less than 500. The sleeve shall be held to the shaft to prevent rotation and shall be gasketed to prevent leakage between the shaft and the sleeve. Minimum shaft sleeve thickness shall be 3/8 inch.

2.04 COUPLINGS

Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk–on fit. There shall be no metal–to–metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas–Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2.05 GUARDS

Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14–gage steel, 1/2–13–15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.06 CAUTION SIGNS

Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION – AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs shall be constructed of fiberglass material; minimum 1/8 inch thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.

2.07 GAGE TAPS, TEST PLUGS, AND GAGES

Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Division 40.

2.08 NAMEPLATES

Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.09 LUBRICANTS

The Contractor shall provide for each item of mechanical equipment a supply of the required lubricant adequate to last through the specified commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment, the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.10 ANCHOR BOLTS

Anchor bolts shall be designed for lateral forces for both pullout and shear per the structural specifications.

2.11 SPARE PARTS

Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified by part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches

high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

PART 3 – EXECUTION

Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

END OF SECTION

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SECTION 44 11 20.17

TWO-STAGE BIOFILTRATION (Biofilter) ODOR CONTROL SYSTEM

SECTION 44 11 20.17

TWO-STAGE BIOFILTRATION (Biofilter) ODOR CONTROL SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. This section consists of furnishing a complete integral two stage biofiltration odor control system consisting of a FRP vessel, biofilter medias, FRP fan(s), irrigation system, recirculation system, interconnecting duct work between the fan and the biofilter vessel, nutrient addition system if required, instrumentation, fluid controls, and control panel as specified to properly operate and monitor the biofilter system.

1.02 DEFINITIONS

A. Contractor: The firm that enters into a contract with the Owner to furnish materials and services at a specified price.

B. Manufacturer: BIOREM Environmental Inc., Victor, NY.

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

D. H2S: Hydrogen Sulfide Gas.

E. D/T: Detection to threshold as per the specified air odor determination method.

F. OU: Odor Unit.

G. Substantial Completion: Date certified by the project engineer on which the project building (or a specified portion) is complete to the extent it can be occupied or used for its intended purpose in accordance with contract and/or regulatory requirements.

1.03 SUBMITTALS

A. Furnish complete fabrication, assembly and installation drawings, together with electrical and instrumentation details and drawings shall be submitted for review. All dimensions, parts, construction details and materials of construction shall be shown.

B. Furnish training and operations manual.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM).
   1. ASTM D883 – Definition of terms relating to plastics.
   2. ASTM D4097 – Standard Specifications for Contact Molded Glass Fiber Reinforced Thermoset Resin Chemical Resistant Tanks.

3. ASTM D3299 – Standard Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks
4. ASTM C582 – Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
5. ASTM D2583 – Test for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
6. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials.
7. ASTM D2563 – Recommended Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts.

B. American National Standard Institute (ANSI).

C. National Electrical Manufacturers Association (NEMA).

D. Air Movement Control Association International (AMCA).

E. American Composites Manufacturers Association (ACMA).

F. Underwriters Laboratories (UL).

G. Canadian Standards Association (CSA).

H. National Fire Protection Association (NFPA).

I. When reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Product delivery, storage, and handling shall comply with Manufacturer's instructions and as follows.

B. The biofilter media shall be stored on a clean level, surface. Avoid cross-contamination of foreign materials during handling and placement. Media shall be covered if stored longer than one week.

C. All electrical and ancillary equipment shall be stored in a climate controlled building greater than 50 degrees F.

D. All packing slips and shipments must be inspected upon delivery to ensure shipments are complete and no damage has occurred during transportation. In the case of an incomplete shipment or damage has occurred, the BIOREM® Logistics Department must be contacted.

1.06 WARRANTIES AND GUARANTIES

A. The Manufacturer shall warrant the biofilter media not to compact, degrade, or decompose for a period of 10 years from the date of Substantial Completion, provided that the system is operated in

accordance with the Manufacturer's printed Operation and Maintenance Manuals.

B. All mechanical components shall be warranted free of manufacturing defects a period of 12 months from substantial completion.

1.07 QUALIFICATIONS

A. The Biofilter Manufacturer shall have at least 5 years experience in design and fabrication of odor control systems as demonstrated by a list of at least 10 successful dual stage modular installations, in service for more than 3 years, of comparable size and configuration with references. All references shall include valid contact names and phone numbers that can be verified.

B. Consideration of alternate biofilter media shall be submitted to the Engineer at least 15 working days prior to the bid date. No alternate biofilter media will be considered unless it has been pre-approved by the Engineer.

C. The Biofilter Manufacturer shall provide the Owner with training and monitoring support service during the first year of operation. The support service must be renewable at the end of the first year of operation.

D. The Biofilter Manufacturer shall maintain regular laboratory facilities for the microbial and chemical support services required for normal operation of the biofilter system. The facilities shall be open for inspection by a representative of the Owner or Engineer.

E. The following type of odor control systems will not be considered equal.
1. Odor control systems using masking agents.
2. Odor control systems using "counter-actants".
3. Odor control systems using granular activated carbon.
4. Odor control systems in which the media is not completely enclosed.
5. Systems that do not provide continuous and permanent recirculation of the first stage of media.
6. Systems that provided structured media that is not free-flowing.

1.08 ACCEPTABLE MANUFACTURERS

The biofilter equipment shall be manufactured by BIOREM or an approved equivalent.

PART 2 – PRODUCTS

2.01 OPERATING PARAMETERS

A. The biofilter system shall be designed to remove odorous constituents from the process air stream under the following operating conditions:

Parameter	Value	Unit
Airflow Capacity	1,000	CFM
H_2S Loading (ave./peak):	25/50	ppmv
Process Air Temperature:	60-105	Degree F
Ambient Air Temperature:	25-110	Degree F
Make-Up Water Source		Potable or Effluent

B. The biofilter system by designed in accordance with the following table:

Parameter	Value	Unit
Number of Reactors	1	
Vessel Pressure Drop	4	Inches WC
Vessel Footprint Dimensions	10' x 12'	D:H, Feet
Minimum first stage EBRT	10	Seconds
Minimum second stage EBRT	20	Seconds
Inlet Water Pressure	40 - 60	psi
Blower HP	5	HP
Blower Pressure Rating	8	Inches WC
Recirculation Pump HP	1 ½	HP

2.02 SYSTEM PERFORMANCE REQUIREMENTS

A. When loaded under average and peak conditions the biotrickling filter system shall provide at least 99 percent removal of H_2S when operated at the design air flow rate.

B. Odor Removal Requirements: The biofilter system shall provide 95% removal for average inlet concentrations or 600 D/T, whichever is greater. (Odor D/T concentrations to be determined using ASTM-E679 with a 20 liter/minute odor panel presentation rate).

C. All components shall be resistant to sun and harsh ocean front conditions. Provide sun/rain shade structure over water box and control panel.

D. Manufacturer shall submit odor removal calculations to demonstrate design criteria has been met. Also submit schematic layout showing required supports, fastening to secure from wind load, damper location, duct sizing, reducer vents, water source, and all related. Manufacturer shall confirm sizing.

2.03 SCOPE OF SUPPLY

A. Biofiltration Vessels

1. The vessel shall be constructed of UV and acid resistant FRP designed to handle a pH of 1-2 as sulfuric acid.

2. The vessel shall be manufactured so that all parts are proportioned to have liberal strength and stiffness and to be especially adapted for the intended working conditions.

3. Vessel shall be designed to operate under a positive pressure of at least 8"WC.

4. Materials:
   a. The vessel shall be constructed of fiberglass reinforced vinyl ester resin or isopthlalic polyester as follows:
   b. The inner shell shall be approximately 25 percent glass and 75 percent resin. The inner shell shall be provided with an internal C-glass surface veil liner to provide for adequate corrosion resistance.
   c. Reinforcing material shall be commercial grade glass fiber containing a coupling agent to produce a suitable bond with the resin used.
   d. All materials shall be suitable for exposure to hydrogen sulfide fumes at a concentration of up to 300 ppm and sulfuric acid at a pH of 1.0.
   e. Ultraviolet absorbers shall be added to the exterior surface for improved weather resistance. Insulated tanks, where applicable, shall have a light gray pigmented exterior gelcoat layer.

5. All surfaces shall be finished so as to obtain complete cure of the resin without air inhibition. The finished laminate shall be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, air bubbles, pinholes and pimples. The vessels shall conform to the Manufacturer's minimum standard for Barcol hardness.

6. The inner surface shall be free of cracks and crazing with a smooth finish and with an average of not over two pits per square foot, providing the pits are less than 1/8-inch diameter and not over 1/32-inch deep and are covered by sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits.

7. The vessel shall be equipped with the accessories as listed below:
   a. Lifting eyebolts (minimum of 4) shall be provided for use in transporting and placing the vessel.
   b. Hold downs (minimum of 4) each consisting of Type 316 stainless steel anchor bolts. The anchor bolts shall be used for anchor bolting to the concrete foundation. Anchorage shall be able to withstand 140 mph winds.

c. All necessary access doors, nozzles and other attachments. Vessel connection flanges shall be compatible with connecting piping and ductwork.
d. Entry Manways shall be provided for each of the two treatment stages with bolted flanged covers, which are rated for 10-psi minimum. Bolted manways shall be provided with 1/8 inch thick full face neoprene gaskets with 316 stainless steel bolts. Provide manways as needed for inspection and access to internals of the biofilter.
e. All bolts and fasteners shall be Type 316 stainless steel.
f. All gaskets shall be EPDM.
g. The media support shall be FRP grid type. Packing support plates and mid-span supports shall be suitable to support the weight of the packing and entrained recirculation solution.
h. Integral sump to allow for continuous water recirculation.

B. Biofilter Media

1. The biofilter media shall be BIOSORBENS® and shall consist of inorganic, inert hydrophilic cores uniform in shape. The media size shall be ¼-inch by ¾-inch.

2. The biofilter media shall not shrink or swell with varying moisture contents.

3. The biofilter media shall be formulated with nutrients, buffering agents and adsorbents.

4. The biofilter media pressure drop shall not exceed ½-inch water column per foot of depth upon system startup.

5. Organic media is not allowed.

C. Biotrickling filter Media shall be synthetic, engineered type, as manufactured by Biorem Technologies Inc. and shall have the following characteristics;

1. Media shall be random packed.

2. The biofilter media shall consist of inorganic inert hydrophilic material, uniform in shape.

3. The media shall not shrink or swell under varying moisture conditions.

D. Recirculation System

1. The first stage recirculation system shall consist of a spray nozzle assembly above the biotrickling filter media stage, and centrifugal recirculation pump. Pipe shall be Schedule 80 PVC. Spray nozzles shall be PVC.

2. Motors are 3 Phase/ 60Hz/460V, Inverter duty, TEFC, Suitable for Class 1, Division 2 classification.

3. The recirculation system shall be operated continuously for entire life of odor control system.

E. Irrigation System
1. The irrigation system shall consist of a spray nozzle assembly above the biofilter media stage.

2. The biofilter media bed shall be irrigated intermittently.

F. Biofilter Fans
1. Fan shall be designed for continuous service.

2. Fans shall be FRP, backward inclined or radial bladed centrifugal type.

3. Fan shall be statically and dynamically balanced.

4. Fan shall be equipped with a slip inlet connection, outlet flange, drain connection at bottom of fan scroll and inspection panel.

5. Fans shall have a 316 stainless steel shaft.

6. Fan shall have self-aligned grease-packed bearings, with neoprene shaft seals and OSHA approved weatherproof motor / drive cover.

7. Fan shall have a 3 phase/60Hz/460V or 575V, TEFC, 1800 RPM Motor, suitable for Class 1, Division 2 and a service factor of 1.15.

8. The fan shall be manufactured by Universal Fan and Blower, or BIOREM approved equal.

G. Auxiliary Equipment
1. A nutrient feed system shall be provided if necessary to maintain optimal conditions for microbial growth. Nutrients shall be required if plant effluent of suitable quality is not available. A polypropylene tank, mixer, and metering pump shall be included to deliver the adequate amount of nutrients to the system. One year supply of nutrient dry blend shall be provided.

2. Sound attenuation blanket to reduce blower decibel.

3. VFD on fan to reduce sound.

2.04 INSTRUMENTATION AND CONTROLS

A. Provide a single control panel to service the biofilter system. Provide all items which are required to implement the specified functions and the functions required for proper system operation.
1. Panel shall contain the local control, monitoring and motor starters for the odor control system components, including:
a. NEMA 4X 304 stainless steel enclosure with mounting pedestal.

b. Hand/Off/Auto switch for recirculation pump
c. VFD controller and Hand/Off/Auto switch for fan
d. Status light for fan
e. Status light for recirculation pump
f. Low flow alarm for recirculation system.
g. General alarm indicating light.
h. Alarm reset pushbutton.
i. Main power On/Off selector switch
j. Power On status light
k. Door-mounted fused disconnect

2. UL certified.

3. Panel shall be mounted a minimum of 3 feet from any potential leak point to comply with NFPA 820.

B. Waterbox

1. A waterbox, which houses components necessary for water recirculation shall be provided.

2. Waterbox to be a NEMA 4X enclosure of either FRP or 304 SST.

3. Waterbox shall contain valves, strainer, and plumbing required for media irrigation.

4. Field connection to external water supply.

5. 120V/1 Phase/60Hz power supply, with fuse block and terminals for all field connections.

6. Waterbox shall be mounted a minimum of 3 feet from any potential leak point to comply with NFPA 820.

7. Waterbox shall contain the following instrumentation:
   a. Flow indicator/switch, to display recirculated water flow rate, signal alarm and shut off recirculation pump in case of reduced water flow.
   b. Flow totalizer on make-up water line.
   c. Pressure indicator for recirculated water flow.
   d. Flow indicator to display blow down water flow rate.
   e. Solenoid valve for irrigation control.

C. (1) Lot fluid control valves and y-strainers as required.

D. Instrumentation External to Waterbox:

1. (2) Differential pressure gauge to measure pressure drop across media.
2. (1) Inlet air temperature indicator (local read).
3. (1)Pressure indicators (water), one on each side of recirculation pump.

2.05 ASSOCIATED MATERIALS

The FRP (odor control) ductwork should be designed by a third party and the plans and specification(s) should be stamped and signed by a SC engineer. Submit shop drawings for approval.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with Manufacturer's written instructions.

B. The Contractor shall give the Manufacturer 5 full working days notice prior to media placement.

3.02 INSPECTION AND TESTING

A. The Manufacturer of the biofilter system shall furnish the services of a factory representative who has complete knowledge of proper operating and maintenance to inspect the final installation and supervise a test run of the equipment. The Manufacturer shall furnish a minimum of 1 trip and a minimum of three (3) eight-hour days total on-site service for mechanical checkout. On-site service required for performance testing shall be in addition to the mechanical checkout service.

B. Install all systems in accordance with Manufacturer's written instructions and recommendations. Media installation procedures must comply with Biofilter Manufacturer's instructions and recommendations.

C. Performance Testing of Odor Control System
   1. Verify conformance to specified parameters, to be conducted using actual inlet conditions of the site. Testing to be completed no sooner than three weeks, but not later than 10 weeks, after system startup and shall include:
      a. Verification of proper airflow
      b. Measurement of inlet and outlet H_2S concentrations.
      c. Test will be conducted for a period of not less than 8 continuous hours with H2S readings being collected every 30 minutes.
      d. Record pressure drop readings across media lift.
      e. In addition, bag samples will be collected at two different times, on the inlet and outlet of the Biofilter, for odor panel analysis.
      f. A report of the test results shall be provided.

D. The following parameters, at a minimum, will be measured and recorded at 30-minute intervals during the test:
   1. Raw air flow rate
   2. Raw air relative humidity
   3. Raw air temperature
   4. Raw air H_2S concentration
   5. Odor Control outlet air H_2S concentration

6. Record pressure drop readings across media
7. Collect bag samples at two different times on the inlet and outlet of the odor control system and have analyzed.
8. Provide a report of the test results

E. The testing equipment used must be capable of measuring the parameters at the design values specified. The H_2S shall be measured with gas sample tubes. The tubes used to measure the effluent shall have a minimum detection limit below the design discharge H_2S concentration specified in Section 2.02.

F. The performance of the system will be based on the arithmetic average value recorded for "Discharge H_2S Concentration."

G. The system will be considered to have passed the performance test if the average discharge H_2S concentration is equal to or less than that specified in Section 2.02.

H. The system will be considered to have failed the performance test if all inlet parameters are within the ranges specified in spec and the average discharge H_2S concentration exceeds that specified in this document.

I. If the inlet parameters are not within the specified ranges and the average discharge H_2S concentration exceeds that specified in this section, this shall not constitute failure. Additional testing with the inlet parameters within the specified ranges may be conducted at the Manufacturer's expense and the Owner's discretion.

J. If the system fails the performance test, the Manufacturer, at the Owner's request, will correct any system deficiencies and re-test at the Manufacturer's expense. No additional payment shall be made for adjustments, modifications and re-testing. Following three failed tests, the Contractor shall replace the system with equipment that meets the specified requirements.

3.03 START-UP/COMMISSIONING

A. Field test and calibrate equipment and demonstrate to the Owner's representative that all equipment performs in accordance with the Specifications.

B. Provide all test apparatus required.

C. Odor Control Manufacturer shall supervise the actual start-up and commissioning of the modular unit.

3.04 PERFORMANCE TESTING BY ODOR CONTROL MANUFACTURER

A. The bio filters manufacturers' representatives shall test the inlet and outlet air using a Jerome 631X H_2S analyzer or equivalent unit with a range of 0.003-50 ppm. The outlet H_2S concentration shall be less than 0.05-0.10 (50 ppb -100 ppb) when the inlet H_2S is 10-20 ppm, respectively.

Approximately, 18 readings shall be taken at ten (10) minute intervals over a three (3) hour period.

B. A performance test protocol will be prepared by the Engineer and the test shall be run within four (4) weeks following start-up.

3.05 WARRANTIES

A. Equipment Warranty

1. The Odor Control System manufacturer shall provide a written equipment warranty. The warranty shall guarantee the prompt repair or replacement (at no cost to the owner) of any component which fails to function properly due to deficiencies in equipment design, workmanship or materials. The warranty period shall be for 12 months from the date of substantial completion and include all costs of equipment, materials and labor.

2. The warranty shall be signed by an officer of the manufacturer of the Biofiltration System. As evidence of intent and ability to provide the warranty, the consent of the manufacturer and the form of warranty shall be submitted for review and approval with the shop drawings.

B. Media Warranty

1. The Odor Control System Manufacturer shall provide a written guarantee that the media will last 10 years. The warranty shall state that the inorganic based media is warranted against physical deterioration and subsequent back pressure increase for a period of 10 years.

2. Should the back pressure continually exceed more than 1-in. of water per foot of bed depth for a one month period during the warranty period due to physical deterioration, the System Manufacturer will correct the situation through reconditioning or replacement of the media. If the media is replaced or reconditioned, the owner will be invoiced on a 10 year pro-rated basis for the period of time the media was in use plus freight and installation costs.

3. The warranty will be contingent on the maintenance of specified operating conditions in the Operations and Maintenance Manual.

4. The warranty shall be signed by an officer of the manufacturer of the Biofiltration System. As evidence of intent and ability to provide the warranty, the consent of the manufacturer and the form of warranty shall be submitted for review and approval with the shop drawings.

C. Performance Warranty

1. Odor Control Manufacturer shall submit a written Performance Warranty which states that the biofiltration system will remove at least 99% of the inlet H_2S for a period of at least ten (10) years if the system is operated and maintained as specified in the Operation

and Maintenance Manual and the annual average inlet H_2S concentration is ten (10) ppm or less.

2. If the system fails the performance test, the manufacturer shall make all necessary improvements and retest the system. Improvements may include media addition or replacement, modification of humidification system and/or the addition of another Odor Control. All costs associated with Odor Control improvements and retesting are the responsibility of the Contractor.

3.06 OPERATOR TRAINING

A. The Odor Control Manufacturer shall provide operation and maintenance training sessions for the Odor Control odor control system, both classroom and field training to the Owner.

B. Training sessions shall be held after successful completion of all Field Tests.

3.07 MONITORING AND SERVICE

A. For a period of 1 year following the date of substantial completion of the Odor Control system The Odor Control Manufacturer shall provide a system monitoring package consisting of, but not limited to, the following:
1. Bacterial Enumeration
2. Media pH
3. Media Moisture Content
4. Particle Size Analysis
5. Nutrient Characterization
6. Mineral Deposit Quantification

B. As a part of this service, data collected by the Owner shall include:
1. Inlet Air Temperature
2. Media Differential Pressure
3. Media Temperature
4. Inlet Air Relative Humidity

C. The package shall include this service at a frequency of every three months. A quarterly report will summarize the collected and analytical data and will list deficiencies, recommendations and corrective actions.

D. The Odor Control Manufacturer shall be recognized and established in the design; production and operation of biological air purification equipment and shall be intimately familiar with the intricacies of providing long term service and monitoring contracts.

E. The Odor Control Manufacturer shall maintain regular laboratory facilities for the microbial and chemical support services required for normal operation of the biofiltration system. These facilities shall be open for inspection by a representative of the Owner or Engineer.

END OF SECTION

SECTION 44 11 20.18

ODOR CONTROL
EXTRUDED ALUMINIUM FLAT COVER

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section defines the design requirements for the aluminum extruded flat cover(s) as described in the contract drawings and documents.

1.02 SUBMITTALS

A. Before executing any of the work in this section, prints or drawings shall be submitted to the engineer showing dimensions, sizes, thickness, gauges, materials, finishes, joint attachment and erection procedure. Drawings shall bear the seal and signature of the design engineer, registered in the state of the project.

B. A complete set of design calculations for the cover(s) shall also be submitted. These calculations shall be signed by a registered professional engineer registered in the state of the project. All work shall be fabricated and erected in accordance with the approved drawings.

C. Certification that the specified material alloys, sizes and quantities have been furnished shall be submitted upon completion of the project.

1.03 REFERENCES

A. The following codes and standards form a part of this section to the extent specified herein:

1. ASTM C–864–90 Standard Specifications for Preformed Gasket and Sealing Material

2. Aluminum Association Specifications for Aluminum Structures

3. Aluminum Association Aluminum Design Manual; Specifications and Guidelines for Aluminum Structures

4. ASCE 8–02 Specification for the Design of Cold–Formed Stainless Steel Structural Members

5. ASTM F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

6. Federal Specification TT – S – 00230C

PART 2 – PRODUCTS

2.01 DESCRIPTION

A. The extruded flat covers shall be clear–span and self–supporting from the peripheral structure. The cover system shall consist of removable panels each weighing no more than 150 pounds. The required lifting force per panel shall not exceed the dead weight of the panel. The extruded panels utilize specially extruded panel structural members, slip–resistant top planks with stiffeners, and integral perimeter flashing/endcaps. Both male and female panels must independently be designed to meet both the design loading and the deflection limits specified herein. Elastomeric weatherseal gasket shall form a continuous substantially watertight seal along all panel edges. The gaskets shall be fully enclosed to prevent ultraviolet exposure.

B. Each panel must be able to be removed without needing to remove more than the two adjacent panels. The need for removing separate flashing or "hold–down" extrusions longer than the width of the panel is prohibited. Primary panel support members shall be integral to the panels. Upon removal of the panels, the entire area beneath the panels shall be exposed and no substructure in the form of beams or box–beams shall remain in the basin(s) to be covered. To facilitate removal, panels shall incorporate integral lifting handles. Handles shall be located at both ends of the cover panels and shall not penetrate the cover panels or pond water.

C. The extruded flat cover shall have an integral bi–directional slip resistant surface which extends a minimum of 0.1–inch above the panel surface. Raised surfaces without the use of texturing to achieve slip resistance are not acceptable. The use of checkered plate, paint, tape, sandblasting, or other applied systems to achieve the slip resistant surface is expressly prohibited.

D. The extruded flat cover system shall be Flush Mount, with the covers slip resistant walking surface flush with the top of the basin or tank wall. Lifting handles shall be integral with the panel endcaps.

E. All metal components of the flat cover structure shall be aluminum or 300 series stainless steel. No galvanized, painted, or plated steel shall be used. The use of structural plastic is expressly prohibited. Dissimilar materials in the supporting structure shall be isolated from the aluminum flat cover by means of a compatible elastomeric gasket.

F. The use of structural members in contact with the contents of the tank is expressly prohibited.

G. The design shall prevent water pooling which may result in over–stressing the flat cover.

H. The extruded flat cover will have a mill finish surface.

I. Fasteners shall be designed with a factor of safety of 2.34 on ultimate strength and 1.65 on yield strength.

J. The removable extruded flat cover system shall be designed to be substantially air and water tight under the specified design loading conditions

2.02 EXPERIENCE/QUALIFICATIONS

A. No equipment shall be supplied by any manufacturer not regularly engaged in the manufacturing and production of extruded flat cover(s) in the size and character herein specified. The manufacturer must have designed, manufactured and installed at least one (1) formed panel flat cover of the same type and size as unit(s) specified herein. This flat cover must be in satisfactory use for a period not less than ten (10) years.

B. The cover manufacturer must own and operate its own US–based manufacturing facility, and the use of a fabrication facility that is not US–based and/or owned and operated by the cover manufacturer is expressly prohibited. Manufactures that do not meet these qualifications will not be considered.

C. The cover manufacturer must be ISO 9001 certified.

2.03 MATERIALS

A. The following is a summary of approved materials and/or material specifications. All aluminum alloys shall be as defined by the Aluminum Association and published in the ALUMINUM STANDARDS AND DATA.

1. **Bolts and Fasteners** – Bolts shall be 300 series stainless steel per ASTM F593, Alloy Group 1. Lock bolts shall be 7075–T73 aluminum or 305 stainless steel. Screws shall be aluminum or 300 series stainless steel.

2. **Structural Shapes** – Aluminum structural shapes shall be alloy 6061–T6 or 6063–T6. Load supporting surfaces shall be 0.1–inch minimum thickness.

3. **Miscellaneous Shapes** – Miscellaneous aluminum shapes shall be alloy 6061–T6 or 6063–T6.

4. **Gaskets** – All gaskets shall be Neoprene conforming to ASTM C–864–90, resistant to ozone and shielded from exposure to ultraviolet light. The gaskets must have a ¼" minimum thickness.

5. **Sealant** – All sealants shall be silicone, GE Silpruf SCS 9000.09 and resistant to ozone and ultraviolet light and conform to Federal Specification TT–S–00230C.

6. **Miscellaneous Penetration Seals**– All other penetration seals shall be weatherproof rubber seals.

7. **Support Bearings** – Bearings at the supports (if required) shall conform to AASHTO Division 2 Section 25. Acceptable bearing surfaces for sliding bearings are Teflon to stainless steel only. In order to avoid damage to the Teflon and to reduce the coefficient of bearing friction, Teflon shall not bear on aluminum surfaces.

2.04 DESIGN LOADS

A. The entire extruded flat cover structure shall be designed to sustain the loads specified herein, within the stress limitations of the Aluminum Association Aluminum Design Manual. In no case shall the formed panel flat cover be designed for any loads less than those specified by the local building code and/or local amendments.

B. The load cases to be considered shall be those described below unless more severe loads are specified by the purchaser.

1. **Dead Load** – The dead load shall be defined as the weight of the structure and all permanently attached to and supported by the structure.

2. **Live Load** – As designated on the drawings.

3. **Snow Load** – As required per ASCE 7–10, but not less than required by local building codes and/or local amendments.

   Importance Factor (I) = 1.0 or greater per ASCE 7–10 Table 1–1.
   Exposure Factor (C_e) = 1.0 or greater per ASCE 7–10 Table 7–2.
   Thermal Factor (C_t) = 1.2.

4. **Non–Uniform Snow Load** – As required per ASCE 7–10 but not less than required by local building codes and/or local amendments.

5. **Wind Load** – As required per ASCE 7–10, but not less than 157 MPH.

   Exposure Factor = C

6. **Vacuum/Pressure Load** – N/A.

7. **Load Combinations** – As required per ASCE 7–10 Section 2.4.1.

8. **Temperature** – The load combinations listed above shall be considered for a temperature change of 100 degrees F below the installation temperature and 100 degrees F above the installation temperature and for a material temperature range of 40 degrees F below 0 to 160 degrees F above zero.

9. **Panel Design Load** – In addition to the above mentioned loads and load combinations, the aluminum panels shall be designed for a **400 pound** load distributed over one square foot at any location. This load is to be taken as acting separately and not simultaneously with other design loads.

10. **Deflection** – For the above loads and load combinations, the deflection of all components (structural and cladding) shall not exceed L/240 with L equal to the span of the component. This deflection limit applies not only to the flat cover as a whole, but also to the decking of the cover spanning between the supporting edges of each panel or module.

Calculations stamped by a South Carolina registered Professional Engineer shall be provided at the time of submittal to ensure that this requirement has been met.

2.05 MANUFACTURERS

A. The aluminum extruded flat cover shall be as manufactured by TemcorConservatek – Gardena, California (310) 353–5100 or Conroe, Texas (936) 539–1747.

PART 3 – EXECUTION

3.01 INSTALLATION

A. All work shall be executed by skilled mechanics with a supervisor experienced in the erection of extruded flat covers. The flat cover shall be erected plumb and level and in proper alignment.

3.02 WARRANTY

A. The extruded flat cover manufacturer shall warrant that the work described herein shall be free from defects, workmanship and material. The flat cover manufacturer shall replace or repair only faulty workmanship or defective material furnished by it that is reported to it within one (1) year from the date of completion of this scope of work.

END OF SECTION

INDEX TO

SECTION 44 42 19

POSITIVE DISPLACEMENT BLOWERS

SECTION 44 42 19

POSITIVE DISPLACEMENT BLOWERS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

45 50 00 Membrane Bioreactor

1.02 SCOPE

A. Provide all labor, materials, tools and equipment required to furnish and install, in good workmanlike manner, Positive-Displacement Rotary 3-lobe blower units with integrated pulsation cancellation. Blower units shall be complete and operational.

B. Blowers(s) shall be designed for continuous duty operation, to provide the air volumes as defined in the Blower Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. Blowers and appurtenances shall be supplied by a CE-certified blower manufacturer with a Quality Control System certified in accordance with ISO 9001. Units shall be furnished as a complete system

B. All equipment furnished under this section shall be furnished by a single manufacturer who shall assume complete responsibility for the design and performance of the equipment. The manufacturer shall have a minimum of five years experience in producing blower equipment and shall produce evidence of at least five installations of similar size in satisfactory operation in the United States.

1.04 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information needed to fully describe the blowers(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. ASME PTC – 9 Performance Test Results.

2. Manufacturer of all components supplied.

3. Model numbers of all component supplied.

4. Rotational speed.

5. Capacity in scfm and icfm.

6. Discharge pressure.

7. dB(A) noise pressure level.

8. Weights of each item of equipment.

9. Major component materials of construction.

10. Blower specification describing construction details.

11. HP required at rated capacity and pressure.

12. Outline Dimension Drawing.

13. Installation Drawing.

14. Complete performance data showing capacity and power input.

15. Electrical Data that includes:

    a. Motor rating, HP.

    b. Motor temperature rating.

    c. Motor full load rotational speed.

    d. Motor full load current.

    e. Motor locked rotor current.

    f. Motor performance curves showing speed, efficiency, current, power, etc.

16. List of recommended spare parts broken down into on hand parts and long term for two years operation and three to five years operation.

17. Manufacturer's warranty.

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include blower and blower package outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information,

mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

1.06 SPARE PARTS AND TOOLS

A. Provide the following spare parts to the Owner, boxed, marked, and ready for long-term storage:

1. One complete set of gaskets, seals, V-belts, as required for each blower size.

2. One additional set of filter elements for each air inlet filter for each blower size.

B. Spare parts shall be properly bound and labeled for easy identification without opening the packaging and suitably protected for long-term storage in a humid environment.

C. One set of Tools required for changing oil and performing belt maintenance shall be provided for each blower size.

PART 2 - PRODUCTS

2.01 BLOWER DESIGN

A. Site Conditions

1. Elevation: 15 feet above sea level

2. Maximum inlet temperature: 95 ºF

3. Maximum humidity (at maximum temperature): 80 %RH

B. Blower Schedules: Blower packages shall be provided to meet to following conditions and duty points:

Blower Name	**Pre-Aeration /Sludge Holding Blowers**
Number of Blowers	2
Maximum Blower Capacity	262 SCFM
Minimum Blower Capacity	49 SCFM
Maximum Differential Pressure (excluding internal blower losses)	6.6 psig
Indoor/outdoor	Indoor
Hazardous Location	No
VFD Controlled	Yes

Blower Name	**MBR Scour Air Blower**

Number of Blowers	3
Maximum Blower Capacity	262 SCFM
Minimum Blower Capacity	49 SCFM
Maximum Differential Pressure (excluding internal blower losses)	5.6psig
Indoor/outdoor	Indoor
Hazardous Location	No
VFD Controlled	Yes

C. Blowers shall be sized so that maximum duty point does not exceed 90% of maximum blower speed.

D. Blowers shall be rotary-lobe, dynamically and statically balanced, tri-lobe design with an equalization chamber integral to the blower housing.

E. The blower rotors are to be balanced according to ISO 1940 class Q 2.5. With respect to acceptable vibration levels, the blowers must operate between effective vibration speeds of 2.8 to 7.0 mm/sec. (0.11 to 0.276 inches/sec.) measured at the bearing housing per VDI standard 2056. For acceptance, all blowers must conform to ISO 2373, Machine Group T.

F. Each blower shall be factory tested per ASME PTC-9 performance test to verify flow, BHP, and slip at design conditions as well as blower maximum conditions. Slip test only shall not be acceptable. The acceptance criteria are +5% tolerance on power and –5% tolerance on flow regardless of the size of the machine. The performance test can be performed in accordance with other internationally recognized standards, such as ISO.

G. Materials and Construction Features

1. Blower Housing

a. Housing shall be fabricated of close-grained high-strength cast iron construction with DIN inlet and outlet connections, provided with a built-in "equalization" chamber, and drive-end head-plate integral to the cylinder.

2. Rotors

a. Rotors shall be stiff-shaft design with the first lateral critical speed at least 120% of the maximum allowable speed.

b. Any torsional natural frequency shall be at least 10% above or 10% below the operating speed range of the blower.

c. The rotor and shaft assembly shall be a one-piece design constructed of ductile iron.

d. Rotors shall be solid or have closed ends.

e. Rotors shall have an integral sealing strip for improved efficiency.

3. Timing Gears

a. Timing gears shall be spur type, precision ground, hardened and carburized, AGMA Grade 11 equivalent quality or better, with minimum service factor of 1.7 at the maximum operating point.

b. Gears shall be secured by bolting and interference fit on precision ground tapered shaft ends.

4. Bearings

a. Bearing shall be high standard cylindrical roller bearings with an L-10 Life of at least 40,000 hours at maximum speed and maximum differential pressure.

5. Seals at Rotor Chamber

a. Rotor chamber seals shall be non-rubbing, vented, labyrinth-type seals. Each seal assembly shall consist of four hardened steel piston rings, an oil deflector, a grooved labyrinth sleeve, and casing wear ring. There are a total of 16 piston ring seals.

b. Provision for venting to atmosphere between the oil-side and the air-side seals shall be included.

c. The use of lip-type seals for internal rotor shaft sealing is not acceptable.

d. Replaceable casing wear rings to protect the seal bores in the headplates are required.

6. Input Shaft Lip Seal

a. The input shaft seal shall be a lip-type seal

b. The seal assembly must include a shaft sleeve, precision ground, with a titanium dioxide coating and a relief taper at the dust lip to reduce friction and heat.

c. The seal assembly must be fully serviceable without removing the front oil chamber cover.

2.02 BLOWER PACKAGE

A. Each blower shall be supplied with a sound enclosure covering the entire blower package including the drive motor, the inlet silencer, and the discharge silencer. The sound enclosure must be designed for easy inspection and maintenance of all blower package components. The

enclosure shall provide suitable protection for outdoor installation under the specified site conditions.

B. The free field noise pressure at three feet from the enclosure shall not exceed 80 dB(A) at the listed operating conditions.

C. The packages shall be driven through V-belts and sheaves. The drive assembly shall be of the high capacity type, oil and heat resistant, with a minimum service factor of 1.5.

D. Automatic tensioning of the V-belts by use of a pivoting, swing frame motor base with adjustable spring assistance and visual indication of V-belt tension shall be provided to insure the V-belts remain properly tensioned with minimal maintenance and to extend V-belt, sheave, and bearing life.

E. The drive guard shall be the manufacturer's standard sheet metal with provision for ventilation. The installed guard shall be fully enclosed, easily removable, and designed to meet current OSHA recommendations and CE standards.

F. The base shall be an elevated, rigid, fabricated steel design with a solid sub-base. The discharge silencer must be integral to the frame in order to minimize space requirements.

G. To prevent transmission of vibration and noise, the base shall include vibration isolators made of rubber in a steel footing. The vibration isolators are to be mounted between the blower base and the package sub-base.

H. Each blower shall be supplied with a combination inlet filter and silencer. Filter element shall be washable by maintenance personnel as a preventative maintenance procedure.

I. Each blower shall be supplied with one inlet silencer. The inlet silencer shall be a combination chamber and absorptive design for maximum sound attenuation. Inlet silencer performance losses shall be included by the blower vendor in the blower performance calculation.

J. Each blower shall be supplied with a discharge silencer. The discharge silencer shall be designed to reduce the pressure noise level emitted by the piping leaving the blower package to 85dB(A) over the entire range of operation, based on a carbon steel, schedule 40 piping of a diameter equal to the blower package nominal connection size.

K. Each blower shall be supplied with a single pressure safety valve on the discharge side of the blower mounted downstream of the discharge silencer and upstream of the check valve. The safety valve shall be set to protect the blower from exceeding its maximum pressure rating. The materials selected for the valve internals shall enable safe and reliable operation at the site conditions. The single valve shall be sized to pass 100% of the design flow. The valve shall be field adjustable, spring loaded, and have a proportional operating characteristic with respect to the pressure set point.

L. Each blower shall be supplied with one check valve that shall be installed on the discharge line. The vendor shall include the pressure losses produced by the check valve in the blower performance calculation.

M. Each blower package shall be supplied with flexible connector(s) or connection to the plant piping. The flexible connectors shall be sized for a standard, schedule 40 pipe diameter and shall prevent the transmission of noise and vibrations from the blower package into the piping. The flexible connectors shall be suitable for the maximum operating temperature and pressure ratings of the equipment in the air stream.

N. A sound enclosure shall be provided as standard, shipped fully assembled and shall be the product of the blower manufacturer to insure proper integration. The sound enclosure shall be sheet steel construction with powder coat finish. The enclosure shall have hinged and/or removable panels to allow maintenance access. Panels shall incorporate locking closures.

O. The enclosure shall have acoustic foam insulation. The sound absorbing material must be self-extinguishing and meet the standard of UL 94, Section HFI.

P. At a minimum, each blower shall be supplied with the following instrumentation:

1. One pressure gauge to measure the discharge pressure. The pressure gauge shall read 0-15 PSI. The pressure gauge shall have a stainless steel case and be glycerin-filled for pulsation dampening.

2. A filter maintenance indicator.

3. One combination temperature gauge/switch, with adjustable switching point and contact, to measure the discharge temperature. As an option, a separate temperature gauge and switch may be supplied.

Q. Blower Motor

1. All blower motors shall be supplied, mounted, and aligned within the blower enclosures.

2. Motors shall be 460 volts, 60 Hz, 3 phase.

3. The motors shall have NEMA Class F insulation and limited to Class B rise.

4. The blower motors shall be NEMA Premium efficiency type.

5. Winding Over Temperature Protection

a. Embedded thermostats, one per winding, normally closed contact, shall be provided for an external thermal alarm or

motor cut out for all motors 40 Hp and above, unless otherwise shown. Thermal cutout leads shall be brought out to the motor terminal connection box. Connection of the over-temperature protection to the control system is the responsibility of the Contractor.

6. Blower motors shall have a 1.15 service factor rating. The blower brake horsepower requirements shall not exceed the motor name plate horsepower under the operating conditions listed in the Blower Schedule.

7. Inverter Duty:

a. All motors for blowers indicated in the Blower Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

ii Inverter grade, 1,600 volt, Class F insulation.

iii Service factor of 1.0 when operated from a VFD.

iv Meeting requirements of NEMA MG1 Part 31.

R. Blower Enclosure Cooling Fan (when required)

1. When required for the proper functioning of the blower, blower enclosure fan(s) shall be mounted in the sound attenuating enclosure.

2. When blower enclosure fans are motor-operated, each fan shall be driven by a separate motor to ensure adequate cooling at all blower operating speeds.

3. Enclosure cooling fan motors shall be of the same operating voltage as the blower motor.

S. Manufacturer's Warranty

1. The blower manufacturer shall warrant the blower equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. Rotary blowers shall be warranted against defects in material and workmanship for a period of 24 months after startup or 30 months from shipment.

T. Manufacturers

1. Aerzen

2. Kaeser

3. Approved equal

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. Manufacturer shall factory-test equipment to detect any defects and demonstrate that they will function satisfactorily under the conditions specified. Testing shall include slip testing and mechanical run testing at full pressure and full speed. Manufacturer shall not supply blowers that do not meet the performance standards

3.02 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete blower package and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.03 INSTALLATION

A. Contractor shall install, level, and align blower package(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on blower piping. Install and secure all service lines as required.

3.04 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed blower packages(s) for visual deficiencies.

B. Prior to acceptance by owner, an operational test of all blowers, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the blower package(s) and materials after installation but prior to acceptance by the

Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 44 42 46

SUBMERSIBLE MIXERS

SECTION 44 42 46

SUBMERSIBLE MIXERS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

45 50 00 Membrane Bioreactor

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of submersible mixer(s) described in this Specification.

B. Each mixer shall include a submersible power cable, guide rail system, power cable support, lifting cable, and controls as required in this specification.

C. Mixer(s) shall be designed for continuous duty operation, to provide complete mixing within the basin volumes defined, and to keep solids from settling in the tank.

1.03 QUALITY ASSURANCE

A. The mixer and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the mixer(s) and associated accessories. The mixer should be supplied by MBR supplier only.

1.04 SUBMITTAL INFORMATION

A. Provide a complete sets of submittal information in PDF format. All pertinent information needed to fully describe the mixer(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer.

2. Type and Model.

3. Rotational speed.

4. Major component materials of construction.

5. Mixer specification describing construction details.

6. Outline Dimension Drawing.

7. Installation Drawing.

8. Complete performance data showing capacity and power input.

9. Electrical Data that includes.

    a. Motor rating, HP.

    b. Motor temperature rating.

    c. Motor full load rotational speed.

    d. Motor full load current.

    e. Motor locked rotor current.

    f. Power cable data.

10. Motor performance curves showing speed, efficiency, current, power, etc.

11. Moisture sensor protection characteristics and wiring diagram.

12. Mixer Mast Assembly.

    a. Hoist and Mast Assembly specification.

    b. Hoist details and materials of construction.

    c. Mast assembly details and materials of construction.

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include mixer outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a troubleshooting guide.

1.06 SPARE PARTS

A. Furnish one complete set of mechanical, lip and O-ring seals for each mixer type or size furnished. All spare parts shall be provided in a separate container that clearly identifies to which mixer they belong.

PART 2 – PRODUCTS

2.01 MIXER DESIGN

A. Service

1. All mixing equipment shall be designed to satisfactorily operate continuously in a submerged waste treatment plant environment.

2. The mixer(s) shall be designed to be easily raised, lowered, removed for inspection or service, and rotated horizontally without the need for personnel to enter the tank. A single cast sliding guide bracket shall be an integral part of each mixer. The single cast guide bracket shall guide the mixer into position and be capable of carrying the entire weight of the mixer and the maximum loads created by the mixer. The mixer, with its appurtenances and power cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 130 feet. FM-approved mixers have a depth limit of 57 feet.

B. Performance

1. The mixing equipment shall be designed based on the following design conditions and criterion:

Basin Name	**Anoxic Basin**
Number of Basins	1
Fluid to be mixed	Returned Activated Sludge
Hazardous Location	No
Solids Concentration (mg/l)	6,000 -15,000
Basin Dia. (ft)	Pl refer the layout.
Minimum SWD (ft)	5
Maximum SWD (ft)	10
Overall Tank Depth (to top of wall, ft)	14

C. General

1. Each mixer shall be of the closed-coupled, direct drive, submersible type design. All components of mixer, including the motor and power cable shall be capable of continuous underwater operation while the mixer propeller is completely submerged. In addition, all components of the mixer shall be capable of operation in air, completely unsubmerged for two hours.

D. Materials

1. Major mixer components shall be of cast iron/carbon steel or 316 stainless steel construction. All exposed hardware shall be 316 stainless steel. All

surfaces coming into contact with tank fluid other than stainless steel shall be protected by a two-part epoxy paint.

E. Propeller

1. The propeller shall be 316 stainless steel having two or three self-cleaning backward-curved blades capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater treatment applications. Each blade shall be precision-cut and welded to the hub. Propeller shall be dynamically balanced so the propeller imbalance does not exceed ISO 1940 G6.3 tolerances to prevent excessive vibrations.

F. Fasteners

1. All bolts, nuts, washers and other fasteners shall be 316 stainless steel.

G. Cable Entry

1. The electrical power cable entry shall be an integral part of the slide bracket.

2. The cable entry seal system shall be composed of elastomer grommets flanked by stainless steel washers all designed with close clearance fits against the cable outside diameter and the cable entry inside diameter.

3. A cable entry seal system shall provide a watertight seal between the electrical connection chamber and motor preventing fluid leakage into the motor.

4. Epoxy cable entry sealing systems are not considered equal or acceptable.

H. Shaft

1. The propeller and motor shaft shall be in integral unit. The shaft material shall be 316 stainless steel designed to meet the maximum loads generated by the mixer.

I. Propeller Shaft Seal

1. The mixer shall be provided with a double seal system consisting of a mechanical seal on the propeller (outer) side of the oil chamber and second mechanical seal on the motor (inner) side, each working independently of the other.

2. The mechanical seal shall require neither maintenance nor adjustment, shall not be damaged when the mixer is run dry, shall be easy to check and replace, shall be capable of running in either direction without damage, and be readily available from any major seal manufacturer. Shaft seals that rely on the tank fluid as a lubricant will not be considered acceptable or equal.

J. Bearings

1. The mixer shall rotate on two permanently lubricated bearings. Bearings shall be lubricated for life design and sized to transfer all radial and axial loads to the mixer housing and minimize shaft deflection for increased bearing and seal life.

2. Bearings shall not require pre-loading and shall be maintenance-free with a minimum L10 (B10) bearing life of 100,000 hours at design conditions. Mixer's having bearings that require pre-loading or periodic lubrication will not be considered acceptable or equal.

K. Sealing of Mating Surfaces

1. All mating surfaces of the mixer shall be machined and fitted with static nitrile or viton O-rings providing watertight sealing. Mating surfaces shall be designed to provide watertight seals when metal to metal contact is made resulting in controlled O-ring compression without special torque requirements. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used as a means of sealing.

L. Motor

1. The multi-pole motor shall be directly connected to the propeller (gearbox designs are not acceptable).

2. The motor shall have a minimum 1.1 service factor, a minimum of 30 feet of power and control cable, be of the squirrel-cage, induction, shell type NEMA B design, housed in an air filled watertight chamber.

3. Stator winding and leads shall be insulated with moisture resistant Class F insulation, or better, which will resist a temperature of 155 ºC (311 ºF).

4. The stator shall be dipped and baked three times in Class F varnish.

5. The motor shall be designed for continuous duty, capable of sustaining 10 evenly spaced starts per hour.

6. The rotor bars and short circuit rings shall be constructed of aluminum.

M. Thermal Protection

1. Each phase of the motor shall contain a bi-metallic temperature monitor in the upper portion of the stator windings to monitor stator temperatures. The temperature monitors shall be imbedded in the stator winding coils, connected in series and coupled to the motor contactor coil providing single switch shutdown capability.

2. The temperature setting shall be a minimum of 260 ºF and will automatically reset once the stator temperature returns to normal.

3. Temperature monitors shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

N. Moisture Sensor

1. Each mixer shall be equipped with an electrical probe to detect the presence of moisture in the oil chamber before bearing and motor damage occurs.

2. The moisture detection probe will provide the capability for remote monitoring of the state of the moisture probe either by monitoring a dry contact or through the generation of a 24 VAC or 120 VAC discrete signal.

O. Galvanic Corrosion Protection

1. When necessary to prevent galvanic corrosion, the mixer guide bracket shall have a chemical and abrasion resistant polyurethane liner and guide rollers preventing metal to metal contact between the guide bracket and the mounting and support system. Also, a polyurethane bushing shall be provided between the lifting cable shackle and the lifting clamp. The chemical and abrasion resistant liner, rollers and bushing are to provide galvanic corrosion protection by completely separating the mixer from the mounting system.

2.02 MOUNTING AND SUPPORT SYSTEM

A. Power Cable Support

1. A 30-feet-long, ¼-inch diameter, 304 or 316 stainless steel power cable support cable shall be provided with each mixer and be permanently attached to the mixer shackle on one end and the upper guide bracket of the mounting system on the other end. The power cable shall be attached to the support cable using sway clamps at a minimum of five-foot intervals.

B. Lifting Cable

1. A 30-feet-long, ¼-inch diameter, 304 or 316 stainless steel lifting cable shall be provided and attached to the lifting clamp shackle on the mixer. A cable cleat shall be provided to store the cable when needed.

C. Mounting System

1. A mounting system shall be supplied by the mixer manufacturer and used to mount the mixer and guide it during installation and removal without entering or emptying the tank. The upper guide bracket shall have a positioning locking plate and locking pin that securely positions the guide rail system at any position within a 150-degree arc in 15-degree increments without entering or emptying the tank. The mixer shall rest on a stop near the bottom of the tank preventing the mixer blades from contacting the tank floor. A 304 stainless steel mast system shall be used to guide and securely hold the mixer in place and be designed to withstand the maximum loads produced by the mixer. The mast shall interface with the guide brackets to guide the mixer securely into position.

2. To ensure the integrity of the mounting system the mixer manufacturer shall supply the support guide brackets. The mast may be is supplied by others.

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The following inspections shall be performed as a routine quality check on each mixer prior to shipment from the factory.

1. Propeller size, motor rating, voltage, phase and frequency shall be checked for compliance with purchase order and specifications.

2. Motor and power cable shall be checked before submergence for insulation damage and the presence of moisture.

3. Pressurize the motor with dry air check for leaks at joints and seals.

4. Before submergence run the mixer to check for correct rotation and ensure mechanical integrity.

5. The mixer shall be submerged in a tank containing water and run completely submerged to check amp readings under load.

6. Motor and power cable shall be checked after submergence for insulation damage and the presence of moisture after removing the mixer from the tank.

B. A quality control check sheet showing that the above testing procedure has been performed and that the mixer successfully passed the tests shall be completed. The quality control check sheet shall be supplied with the final documents.

3.02 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.03 INSTALLATION

A. Install, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

3.04 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed mixers(s) for visual deficiencies

B. Prior to acceptance by owner, an operational test of all mixers and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the mixers and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 44 43 34

FINE DUAL APERTURE DOUBLE DRUM SCREEN
(Bongo Screen)

SECTION 44 43 34

FINE DUAL APERTURE DOUBLE DRUM SCREEN (Bongo Screen)

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division – 1, Specifications sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Under this section of the specifications, the Contractor shall furnish and install two (2) Fine Dual Aperture Drum Screen and two, (2) sets of controls and associated accessories as described herein.

B. The above-described equipment shall be installed as shown on the drawings and described herein.

C. Fine Dual Aperture Drum Screen, controls and accessories shall be the product of a single manufacturer who shall have sole responsibility for providing an integrated system, which is complete and operable in all aspects.

D. Minimum maintenance and high efficiency of screening are prime considerations, therefore design alternatives will not be allowed.

1.03 QUALITY ASSURANCE

A. The manufacturer will have been regularly engaged in the design and manufacture of Fine Dual Aperture Drum Screens as described herein for at least three (3) years. Proposed design alternatives utilizing single aperture screens or different flow patterns are strictly prohibited.

B. Corrosion Resistance: Each drum screen shall be designed for passively resisting corrosion. Dissimilar metals shall be isolated or carefully selected to prevent galvanic corrosion. Passivate all stainless steel surfaces in accordance with ASTM A280 or A967 Standards.

1.04 SUBMITTALS

A. Submit shop drawings and technical information to demonstrate compliance with this specification in accordance with Section 01 00 01 General Requirements. The information shall include the following:
   1. Dimensional and assembly drawings, including plan view and sections, piping, and electrical drawings.
   2. Wiring diagrams for all control panels.
   3. Materials of construction for all components.

B. Operation and Maintenance Manuals: 5 (five) copies of the Operation and Maintenance (O&M) Manuals shall be submitted to the Owner's Representative prior to delivery of the equipment. The O&M Manuals shall include instructions for storage, installation, start-up, and operation maintenance, together with a complete parts list and a recommended spare parts list. The O&M Manuals shall comply with Section 01 78 23.

C. Warranty: The Contractor shall warrant that all equipment furnished under this specification shall be free from defects in the material and workmanship for a period of one (1) year from the date of substantial completion. Warranties shall be in accordance with Section 01 78 36. The manufacturer shall provide 24 hour, 7 days a week phone support.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Fine Dual Aperture Screen and related
   1. Ovivo® Bongo™ Fine Dual Aperture Screen.
   2. Ovivo® Bongo™ Drop Box Bongo Scree. Fabricate to match site layout.

2.02 FINE DOUBLE DRUM SCREEN

A. GENERAL DESCRIPTION
   1. The Fine Dual Aperture Drum Screen will consist of two distinct and separate screening zones, each with a circular array of screen panels or screening mesh contained within a self-supporting frame. The water being screened will first pass through an opening in front of the screen and then from the inside of the screen, through the ProPaPanel® to the outside of the screen totally separating the influent and first stage effluent. As the circular array of screen panels rotate, the debris collected on the inside of the screen will be lifted by a series of debris elevators, where it will be washed into a debris trough within the screen. The first stage effluent will then flow from outside the drum through a second stage mesh screen into the center of the drum. The final effluent will discharge horizontally in line with the screen influent. The screenings captured on the second stage shall be washed into an internal debris trough where they will be conveyed via gravity to join with the screenings removed in the first stage. The combined debris will be compressed and dewatered by the integral compactor. Design alternatives for single stage screens or bottom discharge drum screens will not be allowed due to separation efficiency and hydraulic considerations. Flow will be directed to the center of the screen by a pipe connection

B. SCREENING DRUM
   1. The screening drum shall be manufactured as one piece comprised of two distinct sides with a dividing center hub. The entire drum assembly shall be constructed of Polypropylene. Eight (8) 40-millimeter polypropylene rods shall run the entire length of the assembly in a concentric configuration.

2. The first stage of the drum shall consist of Propapanel® screening panels with 3mm, tapered, molded holes with a minimum open area of 45%. A debris elevator shall be incorporated into the trailing edge of each mesh panel support without any protrusion which could snag debris or otherwise cause clogging of the screen.

3. The second stage of the drum shall consist of 3/4 -inch thick polypropylene mesh supports. The Mesh shall be a precision woven polyester fabric which maintains 100% of its strength in wetted conditions, and absorbs no more that 0.4% water. The mesh shall be mounted and sealed to the drum assembly by means of a rubber cord and dovetail notched assembly around the full circumference of the drum. An access point shall be mounted on the outer circumference of the drum and sealed to the screening mesh to allow service of the inner spray wash. A continuous stainless steel band shall protect the rubber cording and ensure that the mesh seal cannot be easily pulled out of the drum assembly.

4. Sealing between the screening drum and main frame shall be by means of self-lubricating low friction UHMW seal assembly.

C. SCREENING DRUM END SUPPORT PLATES

1. The end plates shall consist of 1.5 inch thick UHMW with integral finger joint drum bearings and labyrinth seals.

D. WASH WATER SYSTEM

1. The Propapanel® screening panels and second stage mesh shall be cleaned by a spray wash system. The spray wash system shall be regulated to 30 psi. Spray nozzles shall be spaced so as to fully clean the screens and direct debris into the screenings troughs. The spray tips shall consist of a base which is screwed into the spray bar, and a ¼ turn spray tip which can be replaced quickly without the need for tools. A manual ball valve, pressure gauge, y-strainer, and explosion proof solenoid valve shall be supplied in the size as shown on the schedule below. Designs utilizing rotating brushes, scraper blades and/or screw conveyors for debris removal and transport are strictly prohibited due to maintenance and reliability considerations.

E. DRIVE SYSTEM

1. The dual aperture drum screen shall be driven by a direct drive system without the use of chains or belts. The screen shall be driven by a shaft mounted helical bevel gear drive unit keyed directly to the drive shaft. The gear unit will be fitted with a flange-mounted electric motor. The gear unit shall have a torque transfer efficiency of at least 96% and a safety factor of at least 1.5. The motor shall be rated for Inverter Duty in a Class 1 Group D explosion proof location. A Nylon 6/6 drive pinion shall be keyed to the drive shaft and engage with the drum above the water line where it mates with a continuous band of Nylon 6/6 gear teeth attached to the outer diameter of the drum.

F. GRIT REMOVAL

1. Grit accumulated in the grit sump shall be removed by an automatic valve. A 4.0-inch motorized Ball valve shall be provided on the grit extraction flange. The Grit fluidization solenoid and grit extraction valve shall open together based on a timer as indicated in the schedule below.

G. SITE DATA

Site	SC Kiawah River Plantation WWTP
Location	Outdoors
Liquid Being Screened	Municipal Sewage
Maximum Water Level at Screen	46.875 inch
Maximum Immersion	50% of Drum

H. HYDRAULIC DATA

Screen Capacity	800 GPM	
Velocity through Inlet Opening	2.5 ft./sec	
Velocity through Propapanels	0.85 ft./sec at 50% Blind	
Velocity through Mesh Panels	0.45 ft./sec at 50% Blind	
Velocity at Outlet	1.3 ft./sec	
Head Loss Across Inlet Opening	.5 inch	
Head Loss Across Propapanels	.25 inch	
Head Loss Across Mesh Panels	.25 inch	
Head Loss at Outlet	.5 inch	
Head Loss Across Screen	1.5 inch	Clean Screen
Head Loss Across Screen	3.0 inch	50% Blind

I. SCREENING DATA

Screen Model	Bongo 8-750-1000
Effective First Stage Screening Width	2.33 Ft.
Effective Second Stage Screening Width	3.25 Ft.
Design Differential	3.28 Ft.
First Stage Screen Panel Opening Size	3.0 mm Diameter or 0.197 Inches
Second Stage Screen Panel Opening Size	1600 micron (or 1.6 mm)
Jet-pipe End Connection	1.5" MNPT
Total Number of Jets	16 (twelve)
Wash water Quantity Required	24 GPM
Wash water Quality	Pre-Screened to 0.5 mm
Wash water Pressure at Jet-pipe	2 Bar or 30 PSI
Torque Limiter Type	Autogard E510 (supplied loose)
Nominal Motor Size (typical)	0.75 kW 1.0 Hp
Motor Speed	1800 RPM variable
Motor Type	Squirrel Cage Induction
Motor Enclosure	Explosion Proof
Motor Insulation	Class 'F'
Motor Supply	460 V – 3Ph – 60Hz
Anti-Condensation Heater Supply	115 V – 1Ph – 60Hz
Screen Nominal Speed	32 ft./min

J. MATERIALS OF CONSTRUCTION

Frame & Tank Construction	Stainless Steel Gr. 304
Drum Screen assembly	Polypropylene
Sprockets	Cast Nylon
Bearing/Seal End Plates	UHMW
Main Seals	UHMW
Screen Panels	9mm Thick Molded Plastic
Wash water Jets	Plastic

K. CONTROLS

1. A Control panel for each screen shall be furnished by the screening system manufacturer.

2. Enclosure shall be NEMA 4X stainless steel.

3. Power Supply: 480 volts, three phase. All controls shall operate on 120 volts maximum. Provide a suitably sized control power transformer with primary and secondary over current protection. Provide a flange mounted control panel main disconnect switch.

4. Remote Signals: Panel shall provide the following:
   a. One, 10 amp form "C" dry contact output for common master alarm.
   b. Receive dry contact input for "Screen Run". (Signal by other).

5. All equipment shall be capable of operating either in manually or automatic mode, as described below.

6. In the event of the overload relay operating, the screening system will stop and lock-out until the reset pushbutton is operated.

7. The screen motors' space heaters are energized automatically when the system is not running.

8. When the screen is operating, the controls shall open the solenoid valve on the wash water system. A timer shall be provided to maintain wash water flow to the screen for an adjustable time period after the screen has stopped.

9. Panel shall include indicator lights showing screen run status, high level alarm and power on status.

10. A timer relay shall energize the grit flush valve and grit fluidization solenoid.

11. An Intrinsically safe panel with E-Stop shall be supplied for each screen.
    a. A NEMA 4X panel shall be supplied for use adjacent to the screen. The Local Panel shall contain an "Emergency Off" switch on the outside of the panel. The panel internally shall provide a terminal block to connect to the intrinsically safe relay in the main screen control panel for the following items:
        1. High Water Alarm
        2. Wash Water Solenoid
        3. Wash Water Pressure Switch

12. Modes of Operation of the screen:

Manual Screen	With the selector switch in "hand" position, each screen may be turned on.
Automatic Screen	With the selector switch in the "Auto" position, the unit will be designed to start automatically. A plant signal (By Other) signaling influent flow or pumps on will be sent. Once the signal is lost the screen shall continue to run for a field set amount of time to ensure all debris has been cleared.
Automatic Screen – timer over ride	With the selector switch in "Auto", If the screen is idle for a field adjusted period of time, the screen will come on a for one and 1/3 full rotation
Automatic Screen – High Water Override	With the selector switch in "Auto", The screen will come on when a High Water alarm is triggered
Manual Wash Water	The wash water solenoid shall open
Automatic Wash Water	With the selector in "Auto" the wash water solenoid will open whenever the screen is on. The wash water will shut off when a field adjustable timer times out after the screen is shut down.
Manual Compactor	With the selector switch is in "Hand", the compactor will turn on.

Automatic Compactor	With the selector switch in "Auto" the compactor will turn on with the screen. The compactor shall shut off when a field adjustable timer times out after the screen is shut down

13. Main Components of each Control Panel

	CONTROL PANELS EACH CONSISTING OF:
One	NEMA 4X Enclosure
One	Main Disconnect - Lockable
One	Main Circuit Breaker
One	Control Panel Transformer
One	Variable Frequency Drive for Screen
One	Motor Starter for Compactor
One	Motor Circuit Protectors
One	Running Hour Meter for Screen
One	Running Hour Meter for Compactor
One	H-O-A Switch for Screen
One	H-O-A Switch for Compactor
One	H-O-A Switch for Wash Water system
One	Intrinsically safe relay
One	Timer for Screen Run
One	Timer for Screen Auto Run
One	Timer for Compactor Run
One	Control Power Light
One	Start Signal Light
One	Screen Running Light
One	Screen Over Load Light
One	Compactor Running Light
One	Compactor Over Load Light
One	Wash Water Running Light
One	Wash Water Low Pressure Light
One	High Water Alarm Light
One	Overload Reset Pushbutton
One	Emergency Stop Button
One	Common Alarm Strobe
One	Lot Necessary Name Plates
One	Lot Terminals and Distribution as required
One	Lot Control Relays as required

14. Mounted externally to the Panel tied to the intrinsically Safe relay will be:

One	High Water Float Switch
One	Locally Mounted Emergency Stop Button
One	Wash Water Solenoid
One	Wash Water Pressure Switch

2.03 FACTORY PAINTING

A. All ferrous metal surfaces, except stainless steel, shall be factory coated in accordance with the manufacturer's standards with a corrosion-resistant, high-build, epoxy coating system. Minimum coating thickness shall be 5.0 mils DFT.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The Contractor shall install the equipment and accessories as shown on the Drawings per the manufacturer's recommended procedures.

B. Pipe connecting the equipment shall not place or cause stress to the placed on the equipment.

C. The Contractor shall install all required anchor bolts in accordance with the manufacturer's recommendations.

D. Contractor shall coordinate with Ovivo to install drop box on screening discharge lines.

3.02 INSPECTION & TESTING

A. Prior to start-up, all equipment shall be inspected by the manufacturer for proper alignment, lubrication, and connection.

B. The Contractor shall have the manufacturer's representative inspect the installation and provide written documentation to the Owner stating that the installation is in accordance with the manufacturer's recommendations.

C. The Contractor shall perform a functional test to demonstrate that the equipment operates as specified.

3.03 FIELD PAINTING

A. Field painting shall be as specified in Section 09 90 00 of these Specifications. Color to be selected by owner.

3.04 MANUFACTURER SERVICES

A. Furnish the services of a factory representative, having full knowledge and experience in the installation of the type of equipment being installed, for two, (2) four-hour days during the installation phase of the equipment.

B. Furnish the services of a factory representative, having complete knowledge of proper operation start-up procedure and maintenance requirements, for one, (1) four-hour day, to inspect the final installation and supervise a functional test of the equipment.

C. Furnish the services of a factory representative, having complete knowledge of the operational and maintenance requirements of the system, for one, (1) eight-hour day. The factory representative shall instruct the Owner's personnel in the proper operation of the equipment in accordance with a schedule approved by the Owner.

3.05 CLEANING

A. Prior to acceptance of the work of this Section, thoroughly clean all installed materials, equipment and related areas in accordance with the requirements of Section 01 77 01 of these Specifications.

END OF SECTION

INDEX TO

SECTION 44 45 16

FINE BUBBLE DIFFUSERS

SECTION 44 45 16

FINE BUBBLE DIFFUSERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide a complete strip diffuser system for the aeration basins as indicated in this section. The system shall be capable of intermittent operation without negative effects. There shall be provided all necessary distribution pipes, couplings, supports, hold-downs, anchors and accessories.

B. All the equipment specified under this Section shall be furnished by a single Supplier (the Aeration Equipment Manufacturer) fully experienced, reputable, and qualified in the manufacture of the equipment specified. The basin has been designed to accommodate equipment supplied by Ovivo USA, LLC.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM).

1.03 SUBMITTALS

A. Prior to release for manufacture of equipment, the Contractor shall submit shop drawings of all equipment. The submittal shall include the following:

1. A complete system description.

2. The number of complete diffuser assemblies.

3. The recommended minimum, design and maximum air flow per diffuser.

4. Head loss versus air flow rate for components of the diffuser assembly at the specified design conditions.

5. A layout of the diffuser system including couplings, fittings and pipe supports.

6. A complete materials list.

7. The equipment supplier's recommended installation procedures.

8. A testing plan designed to ensure consistently good quality and uniformity of the diffuser assemblies.

9. A curve showing the oxygen transfer efficiency of the proposed system for a representative layout section at different air flux rates in the design range. The flux rate (scfm/sqft) shall be based on the horizontally projected area of the diffuser.

10. Submit clean water test data from prior tests performed or witnessed by independent test organizations to demonstrate the capacity of the proposed equipment to meet the specified oxygen requirements. Tests shall have been performed in test tanks or process basins and shall be witnessed by an independent third party knowledgeable about clean water test procedures.

11. Submit a reference list of at least five different applications in domestic wastewater treatment plants of not less than one mgd, with at least five years of successful operation, where the manufacturer has supplied equipment substantially the same regarding design, materials of construction, structural elements and other characteristics to that proposed for this project.

1.04 DESIGN CRITERIA

A. The strip diffuser system shall have the capability to transfer the specified amount of oxygen at standard conditions, Standard Oxygen Transfer Rate or SOTR at standard conditions (14.7 psia, 20° C, zero dissolved oxygen) at the side water depth and maximum allowed air rate and pressure specified below.

Condition	SOR (lb./day)	Air Flow Rate (scfm)	Immersion Depth (ft.)	Min. SOTE (%)
Average Condition	1016	168	11.5	2.1
Peak Day Condition	1250	207	11.5	2.0

B. Strip diffusers system must be capable of operating at 0.6 to 4.8 scfm/sq. ft. flux rate continuously and at a rate pf 0.3 to 0.6 and 4.8 to 7.0 scfm/sq. ft. for several hours per day in mixed liquor.

C. The design shall allow a complete flexing cycle to be performed to maintain the membrane and its perforations in a clean state. When the pressure in the air distribution system is brought below the hydrostatic pressure at the depth of the diffusers, then the pressure on the inside of the membrane shall also be below the hydrostatic pressure and the membrane shall collapse on to the flat base plate causing a flexing movement of the membrane.

D. Strip diffusers shall be AEROSTRIP® (Q, T) Type as supplied by Ovivo. The proposed fine bubble strip diffuser shall be a flat strip design using a flexible membrane installed on the basin floor to utilize the full side water depth. The system shall be designed to withstand the design air pressure plus a 1.5 psig surge factor.

PART 2 - PRODUCTS

2.01 STRIP DIFFUSER ELEMENTS

A. Membrane

1. The strip diffuser membrane shall be a homogenous thermoplastic material from the polyurethane family. The membrane shall have a proven record of performance in more than 25 installations. The membrane must be manufactured as a seamless, calendered sheet without defects or repairs. Membrane materials containing plasticizers or softeners are not acceptable. The surface of the membrane must be smooth to prevent biological growth from attaching. Membrane shall be capable of producing fine bubbles of 1 mm in diameter across the entire surface. Air flow shall be uniform across the entire membrane surface. EPDM, Teflon coated EPDM, and silicone based membranes are not allowed on this project.

B. Frame

1. The frame shall provide structural support for the strip diffuser membrane and be structurally self-sufficient. In addition to securing the entire perimeter of the membrane with an airtight sealing mechanism, the frame shall provide the necessary mechanism for even distribution of air. No fasteners shall be allowed to penetrate the membrane. No discs or tube diffusers are allowed on this project. Only strip diffusers are allowed on this project.

2. The base profile shall be made from PVC. The membrane shall be fastened to the base profile using polyamide tubing.

3. Air shall be supplied to the strip diffuser through a fitting in the end of the diffuser. The air feed fitting shall be made from PVC / PE and is bonded to the base profile.

4. The diffuser shall be anchored by preformed elements (304 SS or PP) and secured by standard bolts, nuts and anchors (304 SS).

C. Assembly

1. The outside dimensions of the strip diffuser shall be approximately 180 millimeters wide and four meters long. The strip diffuser shall be shipped totally assembled by the supplier, ready for installation by the Contractor.

D. Supports and Anchors

1. Anchors shall be fabricated from minimum 3/8-inch diameter type 304 stainless steel threaded rod. Anchors shall be suitable for insertion into concrete slab with epoxy adhesive and shall be sized for a pull out strength five times the calculated buoyant forces.

2. Support profiles, nuts, bolts, washers, and other fasteners shall be made from 304 stainless steel.

3. Consumables such as thread lubricants, epoxy, Teflon tape, etc. shall be supplied by the Contractor.

2.02 DROP PIPE AND AIR DISTRIBUTION SYSTEM

A. The aeration system supplier shall supply all necessary distribution piping for the system and in conformance with this section.

B. Connections to Main Air Supply

1. The drop pipe shall be polyethylene #-inch diameter and meet the requirements of ASTM D 1248, Type III, Class C, Category 5 Grade P34, or ISO S8, 3/SDR 17.6. The pipe shall be connected to the air main piping by a #-inch king nipple (304 SS), supplied by the Contractor, attached to a high temperature rated flexible hose supplied by the strip diffuser supplier.

C. Distribution Pipe and Fittings

1. Polyethylene piping shall be one inch in diameter and meet the requirements of ASTM D 1248, Type III, Class C, Category 5 Grade P34, or ISO S8,3/SDR 17.6.

2. All polyethylene shall be provided in continuous lengths. No field welding shall be required.

3. Provide compression fittings to connect PE piping to diffuser and air header piping.

4. All feed assemblies shall be fabricated for field installation using standard components and couplings.

5. Feed lines shall be easily connected and disconnected to allow purging of debris after installation but before operation. Each distribution pipe shall be supplied with a removable end cap or plug to allow purging of the air lines.

D. Couplings, Pipe Supports and Anchors

1. All supports, anchors and fasteners shall be from 304 stainless steel.

2. Attach supports to the tank floor using epoxy type concrete anchors designed for embedment in 3,000 psi concrete. Space supports at six feet (maximum) center to center. Size anchors for pull-out strength five times the calculated buoyant forces.

E. Service Conditions

1. The piping system shall be designed to withstand the specified field operating conditions including expansion and contraction. The piping system shall be sized to supply acceptable head loss for the specified air flow rates to avoid poor distribution between diffusers.

2.03 SPARE PARTS

A. Provide a minimum of # spare complete diffusers assemblies for each diffuser size supplied including accessories for connection to the air headers and attachment to the threaded rods.

2.04 STORAGE AND INTALLATION

A. All materials and equipment shall be stored, handled and installed in such a manner as not to degrade quality, serviceability or appearance. The equipment shall be stored in a clean, dry location free from construction dust, precipitation and excess moisture as well as extreme temperatures. Crates with strip diffusers as well as individual strip diffusers need to be stored to avoid exposure to direct sunlight and heat (not to exceed 104 °F).

B. The strip diffuser system shall be installed in accordance with approved procedures submitted with the shop drawings and as indicated, unless otherwise approved. The individual diffusers shall not be installed until all other work in the basin has been finished. Care shall be taken to protect the diffusers from physical damages and prolonged exposure to weather without protection. When the diffusers are covered, adequate ventilation has to be provided. Installation during warm weather and in circumstances where diffuser temperature exceeds 104 ºF (e.g., under tarps receiving direct sun, improper planning of work, delays in submerging diffusers with water) or freezing conditions is associated with additional risks and voids supplier's warranty unless the supplier's instructions for those conditions are strictly followed and documented daily.

C. The entire system shall be designed, manufactured, and installed in such a manner that all diffuser elements are within approximately 1/4 inch of a common horizontal plane. At the end of the break-in period, the air distribution shall be uniform over the entire basin.

D. All air piping shall be purged of debris before the aerators are connected and the basins are filled with water.

E. After the system has been installed and the air piping purged, all connections shall be tested for leaks. The basin shall be filled with clean water to a level a few inches above all connections and run at the design air flow rate without any visible leaks. Care should be taken to ensure that the air is properly cooled before entering the PVC piping and diffusers.

F. The tanks shall not be filled with wastewater until the Engineer receives certification from the supplier that the complete system has been installed and tested in accordance with the written instructions of the supplier and that the system is ready for operation.

PART 3 – SERVICE OF MANUFACTURER

3.01 INSPECTION, STARTUP, AND FIELD ADJUSTMENT

A. The Manufacturer shall furnish an authorized service representative for a minimum of two separate trips and a minimum of four days total on-site service. The authorized representative shall also furnish instruction of the Owner's personnel in the operation and maintenance of the equipment. The first trip is recommended before the diffusers are removed from the crates so that the Contractor may gain additional instruction and reduce chances of voiding the warranty.

B. The test runs on the diffuser system shall be undertaken with water in the aeration tanks filled up to the high water elevation shown on the Drawings. The Contractor shall be responsible for providing sufficient water, or treated wastewater for filling the tanks for the test runs on the diffusers. The test runs on the diffusers shall confirm acceptable operation.

PART 4 -WARRANTY

4.01 WARRANTY

The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, F.O.B. its factory, any part or parts returned to it which examination shall show to have failed under normal use and service by the user within twelve months from the date of substantial completion.

END OF SECTION

INDEX TO

SECTION 45 50 00

MEMBRANE BIOREACTOR (MBR) SYSTEM

SECTION 45 50 00

MEMBRANE BIOREACTOR (MBR) SYSTEM

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

The specification sections listed below are an integral part of this equipment specification, and the Contractor shall be responsible for providing these sections to the equipment suppliers.

Section	Description
40 91 00	Process Instrumentation
40 92 13	Electrically-Operated Primary Control Valves
40 92 43	Rotary Actuators
40 95 13	MBR Control Panel
40 95 20	MBR SCADA Hardware and Software
43 21 21	Self-Priming Centrifugal Liquid Pumps
43 21 39	Submersible Liquid Pumps
44 42 19	Positive Displacement Blowers
44 42 46	Water Treatment Mixers
44 45 16	Fine Bubble Diffusers

1.02 DEFINITIONS

A. MBR System Supplier / Supplier: The Company responsible for providing all equipment and services as described herein and for providing warranty support.

B. Contractor: the Company responsible for construction and installation of the MBR System, including, but not limited to, site preparation, tank and basin construction, and mechanical and electrical installation.

C. MBR System: A collective term for all process and membrane zones that make a complete biological treatment system.

D. Process Train: A stand-alone combination of Process Zones designed and operated to achieve specific treatment objectives.

E. Process Zone: An area in a Process Train designed and operated to meet a specific biological treatment objective.

F. Membrane Zone: Any Membrane Tank or MBR containing membranes.

G. Membrane Basin / MBR: A tank or basin containing one or more Membrane Units that are operated as one unit.

H. Membrane Sheet: A flexible, back washable assembly consisting of two filtration layers and a drainage layer. Membrane Sheets are combined to make a Membrane Cassette.

I. Membrane Cassette: Also called a Small Membrane Subunit, the Membrane Cassette is the smallest assembled unit of the Membrane Unit that is designed to be removed from a Membrane Unit and replaced as a complete unit.

J. Membrane Unit: Also called a Large Membrane Subunit, the Membrane Unit is an assembly consisting of one or more Membrane Cassettes and an integral diffuser module. The Membrane Unit is intended to be installed and replaced as a unit.

K. Production Capacity: The net permeate flow rate over a given period of continuous operation accounting for CIP procedures and relaxation. Production capacity requirements are given in terms of:

1. Average Annual Flow (AAF): The net daily flow requirement generally occurring during dry weather conditions and lasting nine months.

2. Maximum Monthly Flow (MMF): The net daily flow requirement generally occurring during wet weather conditions and lasting three months.

3. Peak Daily Flow (PDF): The net daily flow required during peak daily flow conditions and lasting 24 hours.

4. Peak Hourly Flow (PHF): The net peak hourly flow requirement generally occurring during wet weather flow conditions and lasting four hours.

5. Peak Instantaneous Flow: The highest allowable flow rate under any conditions.

L. Flux: Gallons of permeate flow per day per square foot of membrane area (gfd). Additional definitions of flux that are used to characterize design criteria and membrane performance include:

1. Gross Flux: Calculated by dividing measured permeate flow rate by working membrane area at any instant.

2. Instantaneous Flux: See Gross Flux.

3. Net Flux: Calculated by dividing the total amount of permeate produced (available for discharge) in a given time frame by the working membrane area.

M. Maintenance Clean: Synonymous with chemically enhanced backwash and CIP. A Maintenance Cleaning is performed in-situ and in mixed liquor or activated sludge. The procedure is conducted by charging cleaning chemicals to membranes in the reverse direction of permeate flow with a soak time lasting more than half an hour. Typical Maintenance Cleaning characteristics are provided below.

Summary of Maintenance Cleaning Characteristics

Parameter	Value (Condition)	Type
Membrane Soak Time	> 0.5hr	Primary
Conducted In Mixed Liquor	Yes	Primary
Conducted In-Situ	Yes	Secondary
Typical Duration	0.5hr – 2.0hr	Secondary
Fill Direction	Reverse	Secondary
Tank Fill/Drain	No	Secondary
Chemicals Required	Yes	Secondary

N. Recovery Cleaning: Synonymous with intensive cleaning and CIP. A Recovery Cleaning is performed in-situ or ex-situ and in water or dilute chemical. The procedure is conducted by charging cleaning chemicals to membranes in either direction with variable soak times. Typical Recovery Cleaning characteristics are provided below.

Summary of Recovery Cleaning Characteristics

Parameter	Value (Condition)	Type
Membrane Soak Time	Optional	Primary
Conducted In Mixed Liquor	No	Primary
Conducted In-Situ	Optional	Secondary
Typical Duration	6.0hr – 24.0hr	Secondary
Fill Direction	Optional	Secondary
Tank Fill/Drain	Optional	Secondary
Chemicals Required	Yes	Secondary

O. Mechanical Cleaning: Synonymous with manual cleaning, physical cleaning and hand cleaning. Mechanical Cleaning is any instance where membranes are cleaned by hand or machine (water jetting or other) for the purposes of removing fouling or localized dewatering.

P. Localized Dewatering: Synonymous with clogging, sludging and plugging. Localized dewatering is the excessive accumulation of solids at a membrane surface in the form of refractory cake and generally in discrete, localized areas. Often caused by excessive filtration in combination with unequal or inadequate air scouring.

Q. Cycle: A continuous period of operation lasting 1,440 minutes.

R. Days: Defined as calendar days.

S. MLSS: Mixed liquor suspended solids reported as mg/l.

T. Permeability: Equals the instantaneous flux rate divided by the transmembrane pressure (TMP). The units of permeability are gfd/psi.

U. Relaxation: A temporary suspension of membrane filtration with continued air scouring for the purpose maintaining treatment capacity or reducing CIP requirements.

V. Transmembrane Pressure (TMP): The effective pressure differential across the membrane during normal operation. Reported as psi.

1.03 DESCRIPTION OF WORK

A. This Section specifies the requirements for the furnishing, installing, testing, training, and startup of all process equipment required for a submerged membrane ultra-filtration bioreactor system for the treatment of wastewater.

B. The MBR System Supplier shall furnish and commission the MBR System as described in this specification, inclusive of all equipment, instrumentation, scope-specific piping systems, controls, and integration.

C. The MBR System Supplier shall provide the Engineering and Design Services in support of the treatment system design as described in this specification.

D. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the MBR System in accordance with the installation instructions provided by the Supplier. Once installed, the MBR System shall be complete and operational with all control equipment and accessories as specified herein and described in the Contract Documents.

E. Basins sizes, equipment design (with the exception of the submerged membrane units), controls and instrumentation shall all be designed to meet Phase 2 flow conditions as defined in this section. Only additional submerged membrane modules shall be required to upgrade plant design capacity to Phase 2 flow conditions.

1.04 SUBMITTALS

A. Project Submittal – The MBR System Supplier shall submit to the Engineer complete manufacturer's descriptive information for all equipment, instrumentation, and components in the Supplier's Scope of Supply for the Engineer's approval prior to purchase of equipment. The Supplier is to provide three hard-copies and three CDs containing all submittal information organized by component, clearly marking options, models, materials, etc. The Project Submittal shall contain the following:

1. Membrane installation drawings, detailing membrane unit dimensions, materials, weights, locations of lifting lugs/points, and anchor bolt locations.

2. MBR basin mechanical layout drawings, detailing the number of membrane units, air and permeate piping distribution, piping supports, in-basin instrumentation and valves, and all other components comprising the MBR basin systems. Drawings will detail information in plan and elevation/section views and include details as necessary to completely describe the installation requirements. Drawings will be based on the basin/structural design provided by the Engineer.

3. Plan view equipment and instrument drawings showing the location of all components provided by the MBR Supplier. Locations and installation details are to be coordinated with the Engineer's drawings to avoid conflicting information.

4. Manufacturer's literature for all equipment in MBR Suppliers scope of supply. Literature will include (as applicable):

    a. Pump curves

    b. Blower curves

    c. Mixer velocity distribution profiles

    d. Materials of construction

    e. Shop drawings showing all dimensions, sizes and locations of anchors

    f. Minimum, maximum, and design duty points (flow rates and pressures/TDH)

    g. Unit performance and efficiency data

    h. Motor horsepower and voltage

    i. Complete wiring and control diagrams which show the point of connection for the power supply and control system

    j. All project-specific installation data for used by the Contractor.

5. Where manufacturers' standard literature is submitted, it shall be clearly marked to indicate which features are to be furnished under this contract.

6. Process and Instrumentation Diagrams (P&IDs) showing all equipment and instrumentation which will be controlled by the MBR supplier's control system, including components provided by others. P&IDs will differentiate which components are supplied by MBR Supplier. Unless otherwise directed by the Engineer, the MBR supplier is responsible for establishing the tagging scheme for the P&IDs. Tagging scheme will assign a unique tag to all components and their associated I/O. Tagging scheme will organize components by subsystem and train.

7. Instrumentation list and manufacturers' literature and cut sheets, clearly identifying manufacturer, models, ranges, materials of construction, installation details, power supply voltage, wiring information.

8. Valve list and manufacturers' literature and cut sheets, clearly identifying manufacturer, models, Cv range, materials of construction, pressure rating, and dimensions.

9. Valve actuator manufacturers' literature and cut sheets, clearly identifying models, motor horsepower and voltage, control wiring, installation/connection details, torque rating, actuation times, duty cycle, and materials of construction.

10. Control panel drawings, detailing the interior and exterior layouts, components, panel dimensions, and panel materials of construction and NEMA rating.

11. Control panel component manufacturers' literature, clearly denoting model numbers of all PLC components, relays, terminal blocks, power supplies, buttons, switches, fuse blocks, etc.

12. Control panel wiring schematics.

13. Warranty information, detailing membrane design fluxes for all seasonal flow conditions.

14. System start-up and test procedures.

B. Installation and Operations Manual (IOM) – The MBR Supplier shall furnish an Installation and Operations Manual at least two weeks prior to the delivery of the Supplier's equipment on site. The IOM will include Supplier and manufacturer's manuals and drawings detailing dimensions, locations, wiring information, and any other information necessary to convey the correct assembly and installation of the MBR System components provided by the Supplier. In addition to installation documents, the IOM shall include requirements for the Mechanical Inspection and a schedule of events for the System Commissioning. The Supplier is to provide three hard-copies and three CDs containing all information organized by component.

C. Plant Operations Manual (POM) – The MBR Supplier shall furnish a Plant Operations Manual within six weeks after completion of the System Commissioning. The supplier is to provide three hard copies and three CDs containing the following information:

1. HMI (operator interface) User's manual, detailing screens and functions within the operator interface program.

2. Process variables and final control narrative

3. As-built P&IDs

4. As-built electrical schematics and control panel drawings

5. Safety guidelines

1.05 QUALITY ASSURANCE

A. All the equipment and services specified under this Section shall be furnished by a single manufacturer, and shall be standard units of proven ability as manufactured by a competent organization that is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

B. To show evidence of being able to provide the quality of equipment and services described in this specification, the Membrane System Supplier shall submit their quality system ISO 9001 certification. The quality procedures shall provide for a

means of qualifying all sub-vendors and shall specify that the fabrication facility is a critical vendor and shall require inspection. The quality system shall be audited by a third-party independent inspector. Certification shall remain in effect throughout the project startup.

C. All equipment furnished under this Section shall be new and unused and shall be the standard products of a Membrane Manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of eight years.

D. The MBR System Supplier shall have a minimum of 10-year history of designing MBR wastewater treatment facilities.

E. In addition to qualifications specified elsewhere in the Contract Documents, the MBR System Supplier shall provide the location, size, and start-up dates of 10 representative installations that meet the following MINIMUM criteria in order to be considered qualified:

1. Have a plant or process train design capacity equal to the listed MMF (approximately 50%).

2. Utilize the same type of head works (aperture/slot size) and MBR as the proposed system.

3. Use similar aeration and CIP strategies as that of the proposed system.

4. Have been in operation for at least one year at time of bid.

5. Have operated within 25% of nominal rated capacity for a minimum of 12 months at time of bid.

1.06 WORK BY OTHERS

A. The following work and scope of supply is specifically excluded from the MBR Supplier scope but shall be coordinated by the MBR supplier. General contractor is responsible for all work, equipment, and materials.

1. Design and Engineering:

a. Architectural.

b. Buried pipe, including soil requirements, thrust blocks, galvanic protection.

c. Concrete basins.

d. Wall penetrations.

e. Support of piping outside of MBR scope.

f. Seismic design or calculations other than for seismic anchorage of the Membrane Units.

g. Sealing of calculations and drawings.

2. Structural:

a. Building(s) for housing MBR.

b. Concrete tankage for process and membrane zones.

c. Imbedded wall spools, pipe sleeves, pipe seals in concrete tank walls for the various process pipe connections/penetrations.

d. Covers or grating over process and membrane zones.

e. Equipment access platforms, walkways, stairs, etc.

f. Protective coatings for concrete.

g. Anchor bolts for any equipment outside of MBR basin.

3. Mechanical:

a. Mixed-liquor recycle piping, including branch connections and headers.

b. Process air piping.

c. MBR scour air supply piping upstream of tie point as identified in the Contract Drawings.

d. Membrane CIP piping, including branch connections and headers.

e. Pipe supports and hangers unless otherwise noted.

f. Hoist equipment above the membrane basin for installation and removal of the membrane subunits.

g. Membrane tank drain piping, valves, operators, and pumps, if required.

h. Installation of any kind, including equipment and piping within or outside of Scope of Supply.

i. Installation materials for instrumentation and automatic valves, including, but not limited to, air / sample line tubing, fittings, and mountings.

4. Electrical:

a. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from the electrical power source to the MBR System Control Panel.

b. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from MCC to all field equipment.

c. Instrumentation wiring, conduit and other appurtenances required to provide connections as needed between the terminal boxes at the MBR, pumps, etc., and the membrane PLC control panel.

d. Motor control centers, adjustable speed drives, panel boards, transformers, and other equipment necessary to provide power distribution and control for all equipment.

e. Network communications connection to the Plant SCADA and the MBR System SCADA systems (if the two are different).

5. Other:

a. Receiving, unloading and safe storage of equipment at site or a storage facility until ready for installation.

b. Equipment installation.

c. Instrumentation installation including continuity checks and assistance with related loop checkout.

d. Raw materials, chemicals and utilities during equipment testing. This includes potable water for system function testing and seed sludge per supplier requirements.

e. Laboratory services, operating and maintenance personnel during equipment checkout, startup and operations.

f. Onsite painting or touch-up painting of MBR, with the exception of painting required due to damage incurred prior to equipment being received onsite.

1.07 WARRANTY

A. MBR System Supplier shall warranty and replace the membranes under warranty for a period of 10 years. The warranty shall not be pro-rated.

B. All warrantee support, as defined in the warranty statement, shall be provided by the MBR System Supplier directly or through certified sub-contractors.

C. MBR system supplier scope of supply will include influent fine screens and membrane warranty shall be interrelated to fine screen performance. The intent is to insure membrane warranty and fine screen performance are warranted under a single system supplier.

D. MBR System Supplier shall warrant Membrane Units under the following terms:

1. MBR System Supplier shall replace any units that fail before 10 years from the date of successful completion of the System Commissioning.

2. Failure is defined as any of the following:

   a. Inability to meet production capacity requirements as specified herein.

   b. Inability to meet TSS and turbidity requirements as specified herein.

3. The following are specifically excluded from warranted failure conditions:

   a. Exceeding TSS or Turbidity limits due to physical damage of the membranes and/or loss of piping integrity.

   b. Loss of capacity due to failure to operate within design fluxes and permeability limits as defined in this Section.

   c. Loss of capacity due to failure to perform required Maintenance cleans.

E. Supplier shall warranty all other equipment, not specifically mentioned above, against defects in workmanship and materials for a period of one year from substantial completion.

PART 2 - PRODUCTS

2.01 MBR PRODUCT ENGINEERING AND DESIGN SERVICES

A. The MBR System Supplier will provide the following services for items in their Scope of Supply:

1. Biological Process Design Verification – The MBR Supplier shall support the Engineer in providing analysis and verification of the biological process design using EnviroSim BioWin wastewater modeling software and the customer's influent mass loading, diurnal flow curves, peak flow/loading numbers, and permit limits. The Suppler shall verify basin volumes, recycle rates, aerations requirements, chemical dosing requirements, and waste solids projections. The supplier shall provide a written report summarizing the modeling results.

2. Piping Hydraulic Analysis and Design – The MBR Supplier shall provide a detailed hydraulic analysis and mechanical design documentation of each process subsystem contained in the MBR system scope of supply. Using Pipe-Flo simulation software, subsystem piping designs shall be analyzed to verify flow distribution between membrane units, pump duty points and turn down, and flow control valve Cv and rangeability. The supplier shall supply piping design of each system in 3D using Autodesk Inventor, utilizing 1:1 representation of all fittings, instruments, and equipment. Piping design files shall be provided to the Engineer for integration into the design package. The subsystems included in the hydraulic analysis shall include:

   a. Recycle pump systems

b. Process air distribution systems

c. Scour air distributions systems

d. Permeate systems

e. WAS systems

3. Equipment Sizing and Installation Details – The MBR Supplier shall verify duty points and turn-down, supply voltages, materials of construction, communications IO, equipment access and serviceability, area classifications, and pressure ratings for the MBR system's pumps, blowers, mixers, and valves. In addition to identifying manufacturers and specific part numbers for each component, installation details and 2D/3D CAD blocks shall be provided for integration into the Engineer's design package.

4. Instrumentation Design – The MBR Supplier shall provide the Engineer with complete specification and documentation of all MBR system instrumentation. Each instrument's manufacturer, model, size, range, power, communications protocol, units, materials, connections, and area classification shall be documented in ISA Specification forms. Installation details shall be provided in AutoCAD format for integration into the Engineer's design package.

5. Controls Design – The MBR Supplier shall supply MBR system Process and Instrumentation Diagrams utilizing the Supplier's standard symbols and tagging schemes, MBR system control panel layout/fabrication details, and MBR system control panel wiring schematics in AutoCAD for integration into the Engineer's design package. Additional controls documentation shall include PLC architecture diagrams, control panel BOM, panel IO arrangement, loop drawings, and a control narrative of the overall plant control scheme.

6. Specifications - Using CSI MasterFormat 2004, the MBR System Supplier shall provide the Engineer with complete bid specifications for the MBR system and all supporting equipment, instrumentation, piping systems, valves, and control systems for integration into the Engineer's contract and bid documents.

2.02 SYSTEM PERFORMANCE REQUIREMENTS

A. The MBR System tankage, equipment, controls and pumping systems will be sized to hydraulically convey the seasonal and diurnal flows shown in Table 2-1.

B. Operation outside the flow ranges described in 2.02.B shall be permissible provided membrane permeability does not decrease below 5 gfd/psi and/or TMP does not increase above 3 psi for more than six hours of operation in any calendar year of operation.

Table 2-1

Parameter	Influent (Phase1)		Influent (Phase2)	
Average Annual Daily Flow (AADF)[1]	0.11	MGD	0.22	MGD
Maximum Month Daily Flow (MMF)[2]	0.12	MGD	0.24	MGD
Peak Daily Flow (PDF)[3]	0.22	MGD	0.44	MGD
Peak Hourly Flow (PHF)	0.275	MGD	0.55	MGD

C. The MBR System shall be capable of treating raw wastewater at listed flows to the specified effluent criteria shown in Table 2-3.

Table 2-3

Parameter	Influent[1]		Effluent Limit/ Performance Requirement
Average Annual BOD_5	300	mg/l	<=5 mg/l
Average Annual COD	500	mg/l	<=5 mg/l
Average Annual TSS[4]	300	mg/l	<=5 mg/l
Average Annual Daily TKN	40	mg/l	3
Average Annual Daily TP	8	mg/l	N/A
Total N NH3-N NOX (NO_3+NO_2) Organic N	40	mg/l	<=2mg/l (NH3-N)
Turbidity[3]	25	--	<=2 NTU (max.)
Minimum Daily Average Temperature	2	Deg C	--
Maximum Daily Average Temperature	40	Deg C	- -

D. System Configuration

1. The head works will consist of one duty and one standby primary or secondary (fine) screen, each identically sized with sufficient capacity to handle 100% of the maximum hydraulic flow as stated in Table 2-1 Phase 2 flow conditions and as described in this specification's Scope of Supply. Screens must be supplied by MBR system supplier for a complete operational system and fine screen performance will be linked to 10-year membrane warranty.

2. The MBR system shall consist of below process trains:

   a. One Eq. / anoxic basin with a minimum volume of 12,529 gallons.

b. Two pre-aeration basin with a minimum volume of each basin is 15,798 gallons.

c. Two MBR basin with a minimum volume of each basin is 8,688 gallons.

E. The sludge retention time (SRT) shall be 12 days at design conditions and 12,000 mg/l MLSS.

F. The design MLSS in the MBR shall be 9000-13000 mg/l.

G. The MBR system shall be capable of handling the peak daily flow listed in Table 2-1 for a period of 24 consecutive hours without loss of treatment efficiency or damage to the system.

H. The allowable MLSS concentration in the Membrane Zones shall range between 8,000 mg/l and 15000 mg/l.

I. An MBR shall be considered part of the biological process when calculating aerobic volume requirements.

J. The MBR shall be designed to operate at or below a trans-membrane pressure (TMP) of 5.0 psig.

K. Each in-place cleaning shall not require the MBR to be drained.

L. Each in-place cleaning shall not require the MBR to be taken out of service for more than six hours.

M. The MBR shall utilize self-priming centrifugal pumps to filter water. No additional components such as vacuum pumps and air separators shall be required for filtrations purposes.

N. Site Conditions

1. Ambient air temperatures shall be between 15 °F and 105 °F.

2. The elevation above sea level is ten to fourteen feet.

3. Influent wastewater shall contain less than 20 mg/l fats, oils and grease (FOG).

4. No substances shall be placed in the system in quantities which are not biodegradable or toxic to the biological system.

5. The influent wastewater pH shall be between 6-8 SU.

6. Water hardness shall not exceed 300 mg/l as $CaCO_3$.

2.03 SUBSYSTEM SCOPE OF SUPPLY

MBR System Supplier shall furnish the Subsystem Components listed below in accordance with the requirements of this the project Specifications and Contract Documents All

components shall be shipped loose for installation by installing Contractor unless otherwise noted.

A. Headworks

1. Screens with one standby of equal capacity.

a. Screen must consist of two aperture sizes (coarse and fine screen combined through Ovivo's Bongo screening unit) for maximum solids removal.

2. Conveyor, washer, compactors.

3. Basin high and low level switches.

B. Equalization/Anoxic Basin

1. Basin high and low level switches.

2. Basin level sensor/transmitter.

3. Equalization transfer pumps/RAS Pump.

C. Pre-Aeration Basins

1. Fine bubble diffusers.

2. Combination DO/temperature sensor/transmitter.

D. Membrane Basins

1. Membrane Units.

2. In-basin interconnecting air and permeate piping.

3. Permeate header piping and valves terminating with a permeate header isolation valve after the final Membrane Unit branch connection.

4. Air header piping and valves terminating with an air header isolation valve after the final Membrane Unit branch connection.

5. Pipe supports and support anchors for all Supplier-provided piping within the membrane zone only.

6. Basin high and low level switches

E. Permeate Collection System

1. MBR permeate pumps.

2. MBR permeate control valves.

3. MBR permeate process instrumentation.

4. MBR permeate turbidimeters.

F. Cleaning Systems

1. Maintenance Clean system pumps, valves, instrumentation, and tanks (if necessary).

G. Supplemental (Process) Aeration System

1. Process air blowers with one standby of equal or greater capacity.

2. Process air flow control valves.

3. Process air instrumentation.

H. Membrane Zone (Scour) Aeration System

1. Scour air blowers with one standby of equal or greater capacity.

2. Scour air flow control valves.

3. Scour air instrumentation.

I. Internal Recycle System

1. RAS pumps with standby of equal capacity.

2. RAS flow control valves.

3. RAS instrumentation.

J. Controls

1. MBR control panel

2. MBR Operator Interface

3. SCADA and PLC programming

2.04 GENERAL EQUIPMENT DESIGN AND FABRICATION REQUIREMENTS

The requirements listed below are in addition to those called out in the Specifications listed in Part 1.01 of this Specification.

A. Screens

1. Screens shall be designed specifically for the MBR System. The screens shall be capable of handling the peak flows described in this Specification.

2. Redundancy shall be required such that a single screen failure shall not reduce plant capacity or compromise Supplier Warranty coverage

3. The screens shall include sufficient instrumentation so as to support automatic start-up, shut-down, and alarming of high levels.

4. Screens shall be self-cleaning and supplied with conveyors, washers, and compactors to facilitate the removal and minimization of the removed solids.

B. Submersible Mixers

1. Submersible mixers shall be direct driven, close-coupled, guide-rail-mounted, non-clogging propeller type designed for mixing of raw or processed sewage. All components of the mixer shall be capable of continuous submerged operation. The mixer shall be sized to provide complete mixing.

2. All major components of the submersible mixers shall be manufactured of 316 stainless steel. All bearings shall have a minimum B-10 rated bearing life of 100,000 hours.

3. Mixers shall have integral motor thermal overload protection and seal failure (moisture) sensor.

4. The mixers shall be provided with guide rails, guide brackets, and lifting cables.

C. Mixed Liquor Recirculation Pumps

1. Mixed-liquor recirculation pumps shall be capable of passing a three-inch spherical solid.

2. Major pump components shall be cast iron, ductile iron, or stainless steel.

3. Pumps shall be provided inclusive of check valves, isolation valves, inlet and outlet pressure gauges, and expansion joints.

4. Submersible pumps: pumps shall have integral motor thermal overload protection and seal failure (moisture) sensor and be provided with guide rails, guide brackets, and lifting cables.

5. Dry-mount pumps: Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling municipal waste.

D. Fine Bubble Diffuser Systems

1. Fine bubble diffuser systems shall include in-basin aeration piping, pipe drops, submerged manifolds, laterals, diffusers, drain pipes, pipe supports, and purge system.

E. Membrane Units

1. Membrane Units shall:

a. Be the OV400 type as supplied by Ovivo. **Alternate membranes shall not be accepted.**

b. Be constructed of type 304 stainless steel, PVC, and PE components as necessary for operation submerged in mixed liquor as part of an MBR System.

c. Meet Buy America requirements.

d. Be retrievable as a unit including Diffuser Case (one pick removal and install).

e. Be furnished with anchors for securing Membrane Units within the basin.

f. Include one Permeate Module, Mounting Hardware, one Diffuser Case and one Diffuser Assembly.

2. Permeate Modules are:

a. Assembled with permeate piping (manifolding) and four Membrane Cassettes each housing 25 Membrane Sheets.

i Cassettes are manufactured from long-lasting PVC sheets fastened with SS hardware.

b. Equipped with one permeate pipe connection consisting of Schedule 80 PVC 4" ANSI flange.

c. Furnished with all fittings as necessary to make the connection to a common header.

d. Approved by the California Department of Health Services (DHS) under the California Recycled Water Criteria (Title 22 of the California Code of Regulations). Submitters shall provide a copy of the DHS acceptance letter and test report.

3. Mounting Hardware

a. Includes all internal supports and fasteners as required for installation (304 SS).

b. Includes a wall support system consisting of pipe supports and fasteners for easy installation and removal.

4. Diffuser Cases shall:

a. Be fabricated from 304 SS.

b. Be attached to the Cassettes to accommodate retrieval without lowering water level.

c. Accommodate both coarse bubble and medium bubble Diffuser Assembly options.

5. Medium Bubble Diffuser Assembly

a. Consist of separate Aerostrip Diffusers, each fed by a common manifold and easily replaceable.

b. Adjustable Diffuser orientation for rise rate and oxygen transfer efficiency (OTE) optimization approximately 20° (total of 40°) in fixed 5° intervals.

6. Aerostrip Diffusers are:

a. Manufactured from polyurethane (PE) strips.

b. Non-clogging type that do not require mixed liquor for cleaning.

c. Designed to last a minimum of 10 years.

d. Provide a minimum of 1.3%/foot OTE.

7. Membrane Sheets shall be:

a. Ultrafiltration (UF) type with a nominal (average) pore size of 0.04 microns as manufactured by Microdyn-Nadir.

b. Comprised of two PES (polyethersulfone) filtrations layers uniformly fused to and separated by an integral polyester (PE) drainage layer.

i Sheet shall be 2 millimeters in thickness, 8 millimeters apart and sufficiently flexible to minimize or prevent the effects of localized dewatering.

ii Sheet shall be ultrasonically welded on all sides and backwashable.

c. Capable of being aerated during periods of no filtration

d. Easy to recover localized dewatering or clogging in the event of misoperation or operation outside of normal operating conditions.

i Only a routine Maintenance Cleaning shall be required following a dewatering event to recover Specified performance.

ii In situ physical or mechanical cleaning only; no manual cleaning shall be required to recover.

e. Be resistant to damaging debris and self-heal in terms of effluent quality per the following:

i Turbidity shall recover to specified limits within 10 minutes of a damaging event or occurrence provided the resulting cut or abrasion is less than 4" in total length.

F. Permeate Pumps

1. Permeate pumps shall be required when the hydraulic loading as described in this Specification cannot be met using gravity filtration.

2. Pumps shall be sized to handle peak instantaneous flow as defined in this Specification as well as rates associated with backwashing, maintenance cleaning, and aerator flushing.

3. Pumps shall be provided inclusive of check valves, isolation valves, inlet and outlet pressure gauges, and expansion joints.

G. Blowers

1. Blowers shall be provide complete with sound enclosure, inlet filters, discharge silencers, pressure relief valves, check valves, motors, temperature and pressure gauges, over-temperature sensor/switch, expansion joints, belts, and baseplates.

2. Process aeration blowers shall be sized to maintain a residual DO of 2.0 mg/l at MMF flow rates and loadings and a minimum of a 2:1 turndown. Process aeration system shall include a standby blower of equal or greater capacity than the duty blowers.

3. MBR scour air blowers shall be sized such than sufficient scour air is provided to support MMF flows as described in this Specification without requiring additional maintenance cleans. The scour air system shall include a standby blower of equal or greater capacity than the duty blowers

4. MBR scour air blowers shall accommodate a minimum surge or 1.5 psig under normal operating conditions.

H. Cleaning Systems

1. The Cleaning Systems shall include backwash, maintenance clean, and recovery clean systems as required by the Supplier's specific systems.

2. Cleaning Systems shall be inclusive of all chemical feed day tanks, chemical feed pumps, valves, instrumentation, controls, and all other ancillary equipment necessary for a complete cleaning operation.

3. Supplier shall define building space shall to be allotted for all Cleaning systems, including space for:

a. Chemical storage.

b. Mix tanks.

c. Cleaning system equipment.

d. Safety equipment.

e. Containment and neutralization of spent chemicals. Containment space shall include space necessary for separation of incompatible materials to meet International Building Codes and International Fire Codes.

4. The system shall be designed to clean the Membrane Units in-place without requiring their removal from tanks.

5. The cleaning systems shall be sized to clean one Membrane Zone at a time and allow the other Membrane Zones to remain in production.

6. All components of the cleaning systems shall be compatible with cleaning solutions recommended by the Supplier for its system.

I. Valve Actuators

1. In order to reduce operating noise levels to nearby residents, it is preferred that all valves be electric actuated valves.

2. If pneumatic valves are provided by the Supplier:

a. Air supply requirements shall be defined by the MBR System Supplier.

b. Supplier's scope shall include a duty and standby compressed air package. Each package compressor unit shall consist of skid mounted three lobe positive displacement blowers in noise suppression enclosures with as maximum of 85 decibels at three feet, intake filters, noise suppression discharge piping, and electrical motors and soft starters.

J. Instrumentation

1. Identification Tags – All field instruments shall have identification tags meeting the following requirements:

a. Tag number of instruments shall be established by the MBR System Supplier and approved by the Engineer

b. Tags shall be made of stainless steel, engraved with 3/16-inch letters, and attached using a stainless steel cable.

c. Instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel.

K. Piping

1. All MBR System air scour piping shall be Type 304 stainless steel above the waterline. PVC shall be permissible for air scour piping below the water line.

2. Permeate piping shall be schedule 80 PVC.

3. Piping shall have welded, glued, flanged, or mechanical groove (Victaulic) connections.

4. Pipe supports shall be 304 stainless steel Unistrut (or equivalent) systems or 304 stainless steel angle and structural shapes with stainless hardware, clamps, and guides.

5. Transitions from MBR Supplier piping to Contractor's piping shall use ANSI 150 pound flanges unless otherwise noted or coordinated with the Contractor.

6. Insulation, heat tracing and or painting shall be provided by the Contractor.

L. MBR System Controls

1. The MBR System controls shall be housed in a panel. The control panel will house the MBR system PLC and valve Open/Close/Auto switches. The control panel PLC is to be sized to handle all I/O for components in the MBR System as indicated on the P&IDs.

2. The MBR System shall include one Operator Interface containing graphical representations of all equipment and instrumentation and indication and trending of all process values.

3. The Supplier shall be responsible for all programming for the MBR System PLCs, database creations and generation of all graphic display screens, alarm configurations and trends for the operator stations.

4. MBR System controls shall be designed to allow for full manual (hand) operation in the event of PLC failures. Hand operations shall be manageable by two operators for a period of 72 hours.

PART 3 - EXECUTION

3.01 MBR PRODUCT ENGINEERING AND DESIGN SERVICES

A. Supplier shall provide the MBR product engineering and design services called out in this specification in accordance with Table 3-1.

Table 3-1: Engineer and Design Services

Design Documents	Required for 60% Design	Required for 90% Design	Required for 100% Design
MBR Process drawings: piping/instrumentation drawings, for all equipment supplied by Supplier.	✓	✓	✓
MBR Mechanical drawings: dimensioned membrane arrangement plans, sections and details; dimensioned mechanical piping plans, sections, and details	✓	✓	✓
MBR electrical, instrumentation, and control drawings: power/wiring plans and details, one line diagrams, instrument plans, control plans	✓	✓	✓
Manufacturer cut sheet: all manufactured MBR equipment supplied by Supplier showing dimensions and physical and electrical requirements	✓	NA	NA
MBR Installation Instruction Manual for the MBR system supplied by Supplier	NA	NA	✓
MBR Equipment list: all Supplier supplied equipment	✓	✓	✓
MBR system control strategy		✓	✓
MBR Calculations: includes the design data (biological, flow, pressure, volumes, etc.) for the MBR system.	✓	NA	✓

B. The MBR System Supplier shall attend the following design coordination meetings at the Engineer's facility. Allow one full day per meeting.

1. Project kick-off meeting.

2. 60% design review meeting.

3. 90% design review meeting.

3.02 PROJECT EXECUTION

A. Unless otherwise required in the Contract Documents, the MBR Supplier shall provide all submittal documentation as described in this Section no later than eight weeks after receipt of purchase order and notice to proceed.

B. Unless otherwise required in the Contract Documents, the MBR Supplier shall deliver all components in their Scope of Supply, as described in this Section, no later than 18 weeks after receipt of written submittal approval.

3.03 CONTROL SYSTEM FACTORY ACCEPTANCE TEST

A. The MBR System Supplier shall coordinate and conduct a factory acceptance test (FAT) of the MBR control system during which:

1. The PLC control logic and HMI operability shall be demonstrated by systematically forcing I/O to verify all controls functions and HMI screen representations defined in the system control narrative.

2. The MBR control panel shall be inspected for completeness, and workmanship.

B. The MBR Supplier shall provide a minimum of two weeks' notice to the Owner and Engineer prior to the FAT. The Owner and Engineer may, at their option and the expense of others, choose to attend and witness the FAT.

C. Whether or not the Owner and/or Engineer attend the FAT, the MBR Supplier shall provide written documentation and certification of the completed FAT.

3.04 MATERIALS INSPECTION

A. The Contractor shall inspect delivered equipment upon arrival on site for completeness of scope delivery and to verify that all components have arrived undamaged. The Contractor is responsible for notifying the Supplier of deficiencies in quantities or conditions within 28 days from the ship date.

B. The Contractor shall provide all labor, materials, and equipment for unloading, de-crating, organizing, and compiling take-off of received MBR equipment, components, and instrumentation.

C. The Supplier shall make available, upon the request of the Contractor, personnel to assist in the inspection of the Supplier's equipment upon unload at the site. Supplier's personnel shall provide services in accordance with their standard daily rates.

3.05 MECHANICAL INSPECTION PRIOR TO COMMISSIONING.

A. The Contractor shall schedule with the MBR System Supplier to perform a Mechanical Inspection at least two weeks prior to the scheduled Startup and Commissioning of the System.

B. The MBR Suppler shall conduct a Mechanical Inspection of the MBR System to verify that the installation is complete and ready to begin Startup and Commissioning activities. The Supplier shall verify the following:

1. Installation of all equipment per the Engineer's and Supplier's drawings and Supplier's IOM information.

2. Installation of all instrumentation per the Engineer's drawings and IOM information.

3. Completeness of all piping installations.

4. Completeness of all electrical installations.

5. Proper installation of the MBR Membrane Unit diffuser assemblies per the Submittal and IOM information.

6. Completeness of all basins, including removal of all debris that may cause damage to the Membrane Sheets.

7. Review of all pipe integrity testing (leak checking) results.

C. Upon completion of the Mechanical Inspection, the Supplier shall provide written documentation of the inspection results.

1. If the MBR System is complete per the requirements of the Mechanical inspection, the MBR Supplier shall schedule the System Startup and Commissioning with the Contractor. The date for the System Startup and Commissioning is to be established within two weeks of the successful completion of the Mechanical Inspection.

2. If the MBR System is not complete at the time of the Mechanical Inspection, the Supplier shall document system deficiencies to the Contractor, Engineer, and Owner. The Contractor will then complete all necessary work and provide documentation (including digital photographs) of the completed work. After all noted deficiencies are resolved to the satisfaction of the Engineer, Owner, and Supplier, the date for the System Startup and Commissioning is to be established within two weeks.

3. If the Mechanical Inspection deficiencies are deemed as sufficiently important by the Supplier, Owner, or Engineer, the Contractor shall arrange for the Mechanical Inspection to be repeated at the Contractor's expense

3.06 SYSTEM COMMISSIONING

A. The MBR System Supplier shall coordinate with the Contractor, Engineer, and Owner for execution of the System Startup and Commissioning. In advance of System Commissioning the MBR System Supplier shall perform an onsite Mechanical Inspection of the facility and generate a punch list of inconsistencies. The Contractor is required to resolve the punch list items to the satisfaction of the System Supplier, prior to scheduling System Startup and Commissioning. The System Startup and Commissioning will consist of the following:

1. General inspection of systems (lubrication, rotation, calibration).

2. Loop checking, instrumentation, and control system verification.

3. Pipe loss testing.

4. Clean water permeability testing.

5. Sludge seeding.

6. Training.

B. The Contractor shall provide materials and personnel in support of the System Commissioning to fill basins with clean water, transfer fluids, repair/remedy any and all electrical and mechanical issues, provide temporary tie-ins, temporary piping, transfer pumps, etc.

C. The Contractor shall coordinate with the Engineer and Owner to seed the MBR system with sludge at the conclusion of the clean water testing.

D. The System Startup and Commissioning shall begin at the Contractor's discretion, within the limits defined herein:

1. Successful completion of a pre-commissioning Mechanical Inspection is required.

2. Startup and Commissioning shall be no later than 60 days after completion of Mechanical Inspection.

E. The Owner shall operate the plant during the Commissioning Period (14 days minimum); however, Supplier and Contractor shall be allowed to provide onsite assistance.

F. Supplier is responsible for monitoring operating conditions and performance during the Commissioning Period.

G. Supplier shall provide the Owner with a Plant Operations Manual at the end of the Commissioning Period. The manual shall include at a minimum:

1. As-built drawings

2. Safety Manual

3. Computer Control User's Manual

4. As-built control schematics

5. Process variables and control narrative.

H. Supplier shall submit the Plant Operations Manual within 30 days following the end of the Commissioning Period.

I. Membrane permeate quality shall be evaluated to determine compliance of the MBR System with Performance Requirements. If the MBR system fails to comply with requirements of membrane permeate quality, Supplier shall provide the Owner and the Engineer a written plan of modifications to the system (such as repairing damaged fibers, replacing seals, complete replacement of system) to achieve compliance with the requirements. Upon implementation of modifications plan, the permeate quality tests shall re-commence in their entirety.

J. Supplier shall review performance test results and make recommendations and any necessary modifications to bring the plant into the target performance goals.

3.07 TRAINING

A. The MBR System Supplier shall provide Training in the maintenance and operation of all systems included in the Supplier's control system.

B. Training shall be completed prior to the completion of the System Commissioning. All training shall be performed by the Supplier or a factory-certified representative of the supplier or component supplier. Training is to include:

1. Navigation of all screens and menus.

2. Review of automatic operations and controls.

3. Changing process set points.

4. Overriding controls.

5. Manual operation of the system in the event of a power failure.

6. Maintenance cleaning.

7. Trouble shooting.

3.08 PROJECT SCHEDULE

A. The MBR System Supplier shall provide the Scope of Supply and associated services specified in this specification in accordance with the Table 3-2.

B. Firm dates for Deliverables as listed in Table 3-2 will be established by Engineer, Contractor, and Customer upon initiation of the project.

Table 3-2: Project Schedule

Deliverable	Due Date
Design Kick-off Meeting	To be completed within two weeks after notice to proceed.
Submittal of 60% Design Documents	Six weeks after completion of Design Kick-off Meeting.
60% Design Review	Within two weeks of Submittal of 60% Design Documents
Submittal of 90% Design Documents	Six weeks after completion of Design Kick-off Meeting.
90% Design Review	Within two weeks of Submittal of 90% Design Documents.
100% Design Completion	Three weeks after completion of the 90% Design Review.
Submittal Documentation	Eight weeks after notice to proceed. Three with design scope, eight without.
Installation Documentation (IOM)	Two weeks prior to Equipment Delivery at Site.
Factory Acceptance Test	Two weeks prior to Equipment Delivery at Site.
Equipment Delivery at Site	18 weeks after receipt of Approved Submittals.
Mechanical Inspection	Three weeks prior to System Commissioning.

System Startup and Commissioning	To be scheduled upon successful completion of Mechanical Inspection.
Training	Training to be provided at the conclusion of the System Commissioning.
Plant Operations Manual (POM)	Four weeks after completion of System Commissioning.

3.09 SUPPLIER SERVICES

A. In addition to the time necessary to complete the requirements established within this specification and elsewhere within the Contract Documents, the MBR System Supplier shall provide 27 person-days and 7 on-site visits in support of the Services shown in Tables 3-3.

Table 3-3 MBR Project Execution Services

Item	Service	Estimated Person-Days	Estimated Trips	Notes
1	Project Kick-Off Meeting	1	1	One day meeting. Supplier to provide necessary personnel.
2	Material Inspection	2	1	Supplier to verify completed shipment of material at unload.
3	Mechanical Inspection	4	1	Per this Section.
4	Commissioning	15	3	Inclusive of clean water testing and seeding support/startup.
5	Training	5	1	Training during Commissioning.

B. Time spent remedying equipment deficiencies/problems shall not count toward the listed durations and trips.

C. MBR System Supplier shall be given a minimum of two-week advance notice prior to the scheduling of any of the listed Services.

D. All service shall be provided by a factory representative or certified subcontractor.

E. Supplier shall provide telephone support for a minimum period of five years following commissioning during normal working hours.

F. Supplier shall provide a phone number for support during nights, weekends, and holidays in event of an emergency.

END OF SECTION

INDEX TO

SECTION 46 23 66

GRIT DEWATERING CONTAINER

SECTION 46 23 66

GRIT DEWATERING CONTAINER

PART 1 – GENERAL

1.01 DESCRIPTION

Furnish all materials, equipment, and appurtenances required to provide a front loader style dewatering container with a 4 cubic yard capacity, as shown and specified.

1.02 QUALITY ASSURANCE

A. Prequalification Requirements:

Any alternate Dewatering Container manufacturer that is not named or listed as approved equal, must submit the following, 15 days prior to bid to be considered for approval:

1. To be considered, the manufacturer will be regularly engaged in the manufacture of grit dewatering containers.
2. The manufacturer will provide documentation of previous experience with municipal grit dewatering systems in wastewater applications.
3. Pre-qualification submittals from manufacturers will include a complete and detailed proposal of equipment offered, including a detailed description of any exceptions taken to the specification.

1.03 SUBMITALS

A. Shop Drawings:

Submit for review, shop drawings showing the following:

1. Complete description in sufficient detail to permit an item comparison with the specification.
2. Dimensions and installation requirements.
3. Descriptive information including catalogue cuts and manufacturer's specification for components.

1.04 GUARANTEE

A. Equipment:

The equipment furnished under this section will be free of defects in material and workmanship, including damages that may be incurred during shipping for a period of 12 months from date of substantial completion.

PART 2––PRODUCTS

2.01 MANUFACTURER

A. Park USA, of Houston, Texas. To propose an alternate manufacturer, refer to the documentation requirements in 1.01 and 1.02 of this section. If other equipment is proposed, the Contractor must demonstrate to the Engineer and the Owner that all requirements of materials, validation, experience, performance, and workmanship have been met or exceeded by the equipment proposed. Contractors proposing alternate manufacturers will be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical, and civil aspects of the installation.

2.02 GENERAL REQUIREMENTS

A. Provide a dewatering container, completed with filtration media, as shown on the Contract Drawings and as herein specified.

B. Dewatering system will be designed for complete outdoor installation.

2.03 DESIGN, CONSTRUCTION, AND MATERIALS

A: Container Body:

1. Container body is made of heavy gauge steel to withstand the stress of continued use.
2. The sides of the container shall be made of 10 gauge steel.
3. The bottom of the container shall be made of 7 gauge steel.
4. The container shall meet ANSI safety specifications and dimensional standards for haulers.
5. The container shall be designed to be handled by a standard garbage truck.
6. The container shall have 3-way flared fork pockets to easily guide forks into the pockets and protect the container from damage. The fork pockets will have taco gussets welded to the bottom to provide additional strength and protection. There shall be fully welded, no-step gusts across the tops of the fork pockets to provide safety and support.
7. The front of the container shall have rounded bumper pads.
8. The top edges of the container shall be rounded and smooth for added safety during customer loading.
9. The container shall have an interlocking top channel frame to provide added strength.
10. The floor channels shall extend up the front and back walls to create extra support and shall be capped at both ends to prevent debris from entering.
11. There shall be a continuous weld on all inside seams of the container body to provide protection against corrosion.
12. The container lids shall be single wall, double lip.
13. Drain ports shall be provided on each side bottom of the container body. They shall be a minimum of 2 inches with female threads and be equipped with male aluminum camlock fittings and watertight cam lock caps.

B. Filter System:

1. The internal filter support structure shall be comprised of a ¼ inch angle iron frame that is continuously welded to the inside wall of the container at the locations where it touches that walls and floor. The frame shall stand away from the walls by 2 inches and from the floor by 3 inches to allow for free drainage of liquid from the filter cake.
2. Carbon steel perforated plate panels shall be fastened to the frame in order to support the filter media. The panels shall be ¼ inch thick with a hole-pattern of 3/8 inch holes on ½ inch centers.
3. The filter media shall be Park Process MS-7052 and shall have the following characteristics:
   a. Fiber: Polyester.
   b. Color: Green.
   c. Count: 64 X 24 per inch.
   d. Weave: 6 x 2 modified satin.
   e. Warp Diameter: 500 microns.
   f. Weft Diameter: 800 microns.
   g. Weight 39.9 ounces per square yard.
   h. Tensile Strength: 1650 pounds per inch.
   i. Air Permeability: 385 millimeters cubed/millimeters squared/second.
   j. Thickness: 0.083 inches.
   k. Micron Opening: 0 x 325.
   l. Micron Retention: 260.
   m. Open Area: 19%
4. The filter media shall be installed on the floor, both short walls and both long walls. The filter media shall rise to a height of 39 inches above the bottom floor filter.
5. Tie down brackets shall be made from ¼ inch thick flat bar.
6. Stainless steel tie down fasteners shall be used.
7. A sponge rubber (nitrile) gasket shall be installed between the support structure and the perforated plate panels to prevent solids from by-passing the filter media.
8. The perforated plate panels and tie down brackets shall be hot dip galvanized. All other carbon steel surfaces shall be sandblasted with a SSPC SP6 commercial blast, coated on the inside and outside with a two-part epoxy primer, and upper coated with urethane to a combined thickness of 6mls on the outside and 8 mls on the inside.

PART 3––EXECUTION

3.01 INSTALLATION

Install in accordance with drawings, shop drawings and manufacturer's instructions.

END OF SECTION

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SECTION 46 33 00

CHEMICAL METERING SKIDS (Sodium Hypochlorite) AND RELATED EQUIPMENT

SECTION 46 33 00

CHEMICAL METERING SKIDS AND RELATED EQUIPMENT

PART 1 – GENERAL

1.01 SCOPE

A. Chemical feed systems shall be completely assembled, mounted, tested, and delivered to jobsite on a single skid. Components to be mounted on the skid are as required to provide a completely functional system. The chemical metering pump manufacturer shall be responsible for providing the complete skid package and be responsible for all equipment within the skid boundary.

B. Chemical feed skids shall be constructed of one piece double-walled rotationally molded High Density Polyethylene (HDPE) material with adequate supports for all equipment and piping. The HDPE shall be 100% UV stabilized. The front and rear of the skid shall have two notched openings to allow the system to be moved via forklift.

C. The skids shall incorporate a built in containment area with sloped bottom for draining. Containment shall have ½ inch NPT drain connection isolation valve directed toward building depressed floor area.

D. Schedule 80 PVC piping shall be provided for all systems. All piping and accessory support shall be from skid base or rear plane. Suction and discharge piping shall terminate at skid edge.

E. Pump liquid ends must be oriented to allow access. Liquid ends facing back plate shall not be allowed.

F. All valves shall be "Trunion" style to allow easy disassembly of valve and piping system. Vented ball valves shall be utilized for Sodium Hypochlorite service. Seals shall be compatible with the chemical being pumped.

G. Unions shall be provided at pump suction and discharge connections to allow easy check valve removal. A valve must be installed at the termination of discharge piping.

H. Chemical diaphragm metering pumps shall be of the positive displacement, mechanically actuated disc diaphragm design.

I. An amplitude modulation (non-loss-motion) stroke adjust mechanism producing smooth sinusoidal flow output at all stroke length settings, driven by a variable speed AC motor, shall actuate a disc, Teflon diaphragm.

J. Solenoid-driven pumps, peristaltic hose pumps, and tubular style diaphragm designs will not be accepted.

K. Manufacturer of the metering pump shall have been engaged in manufacturing of quality, first-class design of metering pumps with an overall experience of minimum

of ten (10) years in the United States.

L. Any proposed metering drive and liquid end design offered by a metering pump manufacturer shall have a demonstrable field experience data including references for a minimum five (5) years of installation in the United States.

M. The chemical feed metering pump system shall be designed, coordinated, and supplied by a qualified SUPPLIER who is a manufacturer of metering pumps and regularly engaged in the business of designing and assembling liquid chemical feed systems for use in water and wastewater treatment projects.

N. Manufacturers willing to submit alternate chemical feed metering equipment as a System Supplier will provide pre-qualification submission with manufacturing experience, model selections, technical literature, and all deviations on specification and must receive approval fifteen (15) days prior to bid date from the Engineer on any alternate bid submission for consideration on the project.

O. Contractor's willing to submit an alternate manufacturer bid as a System Supplier will bear full responsibility of all additional costs associated with any changes associated to equipment piping, electrical wiring and installation layout, including any design engineering review of submittals more than once.

PART 2––PRODUCTS

2.01 CHEMICAL METERING SKID

A. DRIVE:

1. Chemical metering pump gearbox mechanism will be a true sinusoidal amplitude modulation (non-loss-motion) stroke adjustment design to ensure chemical delivery during 100% of each discharge stroke cycle at infinite stroke settings. This will ensure minimum shock to pump gearbox and result in extended pump life. Lost-motion drive mechanism designs that deliver "slug feed" chemicals during portions of the discharge stroke cycle will not be acceptable.

2. Metering pump drive mechanism shall be variable eccentric cam design.

3. The drive housing shall be heavy-duty industrial grade, constructed of cast iron or aluminum, and shall be painted with corrosion resistant epoxy paint. Plastic gear boxes are not acceptable.

4. The gearbox shall be totally enclosed with no opportunity for moving parts to be exposed during operation. All moving parts shall be lubricated by bath-splash lubrication.

5. The motor shall be coupled to the gearbox utilizing a C face flange adapter. Pumps with separate base plates and foot-mounted motors are not acceptable. Integral motors that do not have NEMA C face mounting designs are not acceptable.

B. LIQUID END:

1. The process diaphragm shall be Teflon. Diaphragm shall incorporate convolutions, for unconstrained, rolling action. The diaphragm shall have a minimum design life of one year at operating conditions.

2. The diaphragm shall be returned to its rearward suction position by mechanical connection to plunger.

3. An integral degassing valve incorporating a discharge check valve and a continuous vapor bleed port valve from the displacement head will be furnished to prevent a vapor locked condition in the liquid end for off-gassing chemical metering applications.

4. Accurate, repeatable flow shall be ensured via single ball check valves. Seats shall be machined to ensure accuracy and repeatability. Molded plastic seats are not acceptable. Valves shall be precision engineered designed to operate with guides to ensure precise seating of the check ball for optimal metering accuracy and minimal wear.

5. Each pump shall have a maximum capacity equal to or exceeding flow rating per schedule and be rated for continuous duty against max discharge pressure as per schedule below. Pump nameplate shall reflect this rating.

6. Chemical Feed Metering Pump(s) shall be Milton Roy MacRoy Series metering pump or Engineer Approved equivalent.

C. MANUAL CONTROL:

1. Stroke length shall be controlled manually via a micrometer-type adjuster with locking mechanism. Adjustment, without damage, must be possible while operating or stopped.

2. A percent scale and Vernier shall indicate stroke length in 1.0 % increments.

3. Feed rate shall be infinitely adjustable from 0 through 100%.

4. Metering pump accuracy must be plus or minus 2 % throughout turndown range of 10:1. Turndown range for micrometer adjustment only shall not exceed 10:1.

D. AUTOMATIC CONTROL:

1. All pumps shall be equipped with AC variable speed motors. Motors shall be chemical duty construction and rated for at least 10:1 turndown with constant torque output. Motors shall be driven by a VFD Variable Speed Motor Control – Suitable for turndown in speed and constant torque of up to 10:1. Pumps shall adjust speed based upon flow from effluent flow meter.

2. Stroking speed shall be controlled automatically, via a VFD Control Unit for speed variations of an AC inverter duty motor without encoder feedback.

3. The VFD Control Unit shall be housed in a NEMA 4x enclosure and mounted

on the skid. Flexible conduit will be used to wire motors to VFD drives.

4. A start/stop switch, auto/manual switch, and digital speed readout meter shall be provided.

5. The pump stroking speed shall be regulated manually via a digital keypad or automatically, by a 4-20 mA process variable input signal.

6. The Control Unit shall include a 4-20 mA output and at least 2 Form C output relays.

7. Controller shall provide 0.1 % of full speed regulation. This will ensure no more than 1% variation in actual motor speed at 10:1 turndown.

E. ACCESSORIES:

1. Calibration Column(s).
   a. Provide one for each chemical skid.
   b. Sizing shall allow 30-second draw down test with pump operating at maximum capacity requirements per each chemical feed service.
   c. Materials of construction shall be PVC.
   d. Columns shall be provided with NPT connections at the bottom and also the top for vent pipe connection.

2. Back Pressure Valve(s).
   a. Provide one back pressure valve for set of chemical metering pumps.
   b. Sizing shall allow maximum capacity requirements per service to pass through at a set pressure of 50psig above maximum suction pressure.
   c. Inlet and Outlet connections shall be a minimum of ½ inch NPT.
   d. Design shall use a Teflon diaphragm to isolate an externally adjustable spring. Adjustment range shall be from 10 to 150 psig minimum. Designs utilizing springs within the fluid pumped are not acceptable. Valves shall be designed for at least 150 psig working pressure.
   e. Materials of construction shall be corrosion resistant to fluid pumped.

3. Safety Relief Valve(s).
   a. Provide one external pressure safety relief valve located in the discharge piping for each chemical metering pump.
   b. Sizing shall allow maximum capacity requirements per service to pass through at a set pressure of 75psig.
   c. Inlet and Outlet connections shall be a minimum ½ inch NPT.
   d. Design shall use a Teflon diaphragm to isolate an externally adjustable spring. Adjustment range shall be from 0 to 100 psig minimum. Designs utilizing springs within the fluid pumped are not acceptable. Valves shall be designed for at least 150 psig working pressure.
   e. Materials of construction shall be corrosion resistant to fluid pumped.

4. Pulsation Dampeners
   a. Provide one pulsation dampener for each set of chemical metering

pumps installed in discharge line.

b. Sizing shall result in no more than plus or minus 5% variation in average pressure in the discharge line. Variation shall be checked and confirmed on pressure gauge installed downstream of dampener. System supplier shall provide sizing calculations that must be included in submittals.

c. Design shall incorporate an elastomeric diaphragm constructed of a material that is resistant to fluid pumped. Submittal data shall include chemical compatibility charts confirming elastomer suitability with each fluid pumped. Rating must be highest available representing recommended for use.

d. A gas charging valve and liquid filled pressure gauge shall be mounted on each dampener.

e. Materials of construction of dampener wetted parts shall be corrosion resistant to fluid pumped.

5. Pressure Indicator(s) with Diaphragm Seal.

a. Provide one pressure gauge with diaphragm seal for each set of chemical meter pumps as shown on drawing.

b. Design assembly shall include diaphragm seal and compatible liquid filled gauge. Gauge must have 4 ½ inch diameter face and include scale from 0 to 150 psig.

c. Materials of construction of wetted housing and diaphragm seal must be compatible for use with fluid pumped.

6. Provide one (1) Wye type strainer at the inlet piping. Strainer shall be PVC, with 20 mesh screen and O-ring seals that are compatible with fluid pumped.

F. SPARE PARTS AND SPECIAL TOOLS:

1. For each identical chemical metering pump per designated chemical service, provide the following spare parts:

Quantity	Description
2 or 4	Seats for suction and discharge cartridges (if double ball seats are required per spec – supply 4).
2 or 4	Check valve balls (if double ball seats are required per spec – supply 4).
1 Set	Check valve gaskets and O-rings.
1	Diaphragm.

2. Provide a set of all special tools required to perform maintenance and repair.

3. All parts and tools shall clearly identify the equipment to which it applies and be packaged for prolonged storage.

G. PAINTING

1. All exposed metallic metering pump and accessory surfaces shall be prepared and painted with corrosion resistant epoxy paint. 300 series stainless steel surfaces are excluded.

2.02 RELATED EQUIPMENT

A. Provide storage tanks suitable for chemicals. Tanks shall be equivalent to those by Snyder Industries, Inc. and shall include:
   1. Sight level.
   2. Overflow.
   3. Drain.
   4. Manway.
   5. Fill cap.
   6. Vent outlet.

   Tanks shall be sized to fit through the door into the chemical room.

B. Provide level sensor connected to Scada system to monitor level of chemical in tanks. Sensor to be similar to Flowline or EchoPod DL14 Sodium Hypochlorite Tank Level ultrasonic level senor/transmitter.

C. Water Softener - Furnish and install a Marlo Model MGT-15-3/4 (single) or Culligan HE-060 water softener or approved equivalent. Vessel(s) shall be manufactured of fiberglass reinforced polyester (FRP). The exterior side shall be reinforced by a continuous roving glass filament overwrap of the same color as the vessel(s) shell. The water softening equipment shall be warranted against failure due to faulty materials, and workmanship for a period of one (1) year from the date of substantial completion. In addition, the fiberglass reinforced pressure vessel(s) shall be warranted for a period of five (5) years.

PART 3––EXECUTION

3.01 INSTALLATION

A. The equipment shall be installed per the contract documents and manufacturer's recommendations.

B. Lubrication: Oils and lubricants required for initial operation shall be included. Metering Pump Manufacturer will provide food grade lubricant for all WWTP chemical feed application.

3.02 FIELD TESTS

A. Functional Test: Prior to plant start up, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test.

B. Performance Test: The Contractor shall perform field tests on the completed pump installation to demonstrate their conformance to the Specifications to the satisfaction of the Engineer. A test log with results shall be presented to the Engineer upon completion of the following tests:
   1. Maximum Flow: The pump micrometer and or speed control shall be adjusted to produce the maximum required flow rate per pump schedule as confirmed by calibration column. Once established, two consecutive capacity tests shall be conducted and results recorded.

2. Accuracy at Max Flow: Pumps shall demonstrate accuracy at maximum required flow rate as confirmed by calibration column. The variation in flow rate of the two tests from item 1 shall not exceed plus or minus 1% of the maximum required capacity. Confirm. If results are greater than plus or minus 1% of the maximum required capacity, repeat test and record results of two consecutive tests. Confirm.
3. Accuracy at Minimum Flow: The pump micrometer and or speed control shall be adjusted to produce the minimum required flow rate per pump schedule as confirmed by calibration column. Once established, two consecutive capacity tests shall be conducted and results recorded. The variation in flow rate of the two tests shall not exceed the values established depending on type of control per items 2.03 and 2.04. Confirm. If results are greater than limits, repeat test and record results of two consecutive tests. Confirm.
4. Calibration Chart: A chart shall be created graphing pump micrometer setting vs capacity, using calibration column testing at 0%, 25%, 50%, 75%, and 100% for each pump at 100% speed. Chart shall be presented to Engineer.
5. Pumps with variable speed motors: Motor speed shall be varied from maximum speed down to minimum speed while pumping against maximum required discharge pressure. Motors shall not cause drive overload during 10 minutes of operation at minimum speed.
6. Manufacturer's representative shall be contacted to address any units failing to meet the field test specifications. Manufacturer's representative shall correct deficiencies, and together with the Engineer, retest failed units.
7. Pumps failing to meet this final test will be rejected, and a new unit that will perform as specified shall be provided and retested.

3.03 MANUFACTURERS' SERVICES

A factory-trained, qualified Manufacturer's technical personnel or designated technical Representative shall be available to provide installation, start up, and operational training assistance to Contractor and Owner personnel as per schedule below:

A. One 8- hour day for installation assistance and inspection in one or two trips.
B. One 8-hour day for start-up including functional and performance testing and completion of Manufacturer's Certificate of Proper Installation in one or two trips.
C. And one 4-hour day for classroom or job-site training of Owner's personnel on same trip.

Items 2 & 3 may be combined in the same trip. A Start Up and Commissioning Report including completion of final Operator training on a Manufacturer Start Up Report Form must be completed and signed by all concerned parties for approval of the chemical feed system.

3.04 WARRANTY

The equipment/system warranty, unless otherwise stated, shall be 1 year from final acceptance of the Project or 3 years from date of shipment, whichever occurs first.

END OF SECTION

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SECTION 46 33 33

LIQUID POLYMER PREPARATION EQUIPMENT

SECTION 46 33 33

LIQUID POLYMER PREPARATION EQUIPMENT

PART 1 – GENERAL

1.01 GENERAL

A. The contractor shall furnish and install one (1) liquid polymer blending unit. The equipment is to be supplied by a single, engineer-approved, equipment supplier for installation by the contractor.

1.02 WORK INCLUDED

A. Major components of the liquid polymer blending unit to be supplied under this section shall include, but not be limited to the following:
   1. Liquid polymer blending unit.
   2. Spare parts and accessories.
   3. Start-up and training services.

1.03 SUBMITTALS

A. Submittals shall include the following information:
   1. Dimensional drawings as required for the installation.
   2. Electrical wiring diagrams as required for the installation.
   3. Installation instructions.
   4. Sufficient information on each component to show that the equipment meets this specification.

1.04 QUALITY ASSURANCE

A. Components and installation shall comply with the Uniform, Standard, and National Building and Fire Codes.

B. Pre-assemble and factory test system to ensure compliance with pressure and operation requirements.

1.05 WARRANTY REQUIREMENTS

A. The polymer blending system shall be covered by a two (2) year conventional warranty. The mixing chamber shall be covered by a LIFETIME warranty covering the repair or replacement of the mixing chamber or any part of the mixing chamber which fails for any reason, excluding weather related or over-pressure failures. In addition, the mixing chamber shall be warranted against plugging for any reason. If plugging occurs, the mixing chamber shall be repaired or replaced at no cost to the owner. Metering pumps, options, and accessories shall be covered by a conventional one year warranty. The full warranty shall be valid regardless of whether potable or non-potable dilution water having high solids content, is used.

PART 2––PRODUCTS

2.01 MANUFACTURERS

A. Provide a polymer blending and feed system as manufactured by Fluid Dynamics of North Wales, PA or Engineer pre-approved equivalent. The "or equivalent" clause shall be defined as a system which has a minimum five (5) years proven track record of providing performance at least equal to the specified equipment; with the types of polymers specified below as proven by actual field trials; a design which inherently provides an equal level of reliability and quality compared to the system specified and with equal accessibility of parts for operation and maintenance.

B. Alternates: The manufacturer of alternate equipment shall submit with their bid a list of ten (10) installations, each at least three years in operation, which quantify the proposed alternate system's ability to meet the above criteria. All variations to these specifications must be listed in the manufacturers proposed scope of supply submitted at time of bid. The drawings and specifications are based on Dynablend. Contractor shall include in the bid, and shall be responsible for the costs of any changes to accommodate other equipment, including but not limited to structural, mechanical, and electrical work. Contractor shall also pay any additional costs necessary for revisions of drawings and or specifications by Engineer.

2.02 DESIGN CRITERIA

A. The polymer dilution/feed unit shall be capable of automatically metering, diluting, activating and feeding liquid polymer with water.

B. The polymer dilution/feed unit shall be capable of producing polymer solution with polymer-to-water solution concentrations between 0.25% - 1.0%.

2.03 PERFORMANCE REQUIREMENTS

A. The liquid polymer blending unit shall automatically meter, mix and blend concentrated liquid polymers with dilution water.
   1. The polymer input capacity of each unit shall be: 0.3 to 3 gph of concentrated polymer using a liquid concentrate pump.

   2. Dilution water range shall be: 120 to 1200 gph.

2.04 SERVICE CONDITIONS

A. Dilution Water supply pressure shall be a minimum of 35 psi greater than the mixing chamber discharge pressure.
B. Control Panel supply voltage shall be: 120 VAC.

2.05 EQUIPMENT

A. MULTI-ZONE MIXING CHAMBER
   1. A non-mechanical hydrodynamic blending device specifically designed to dilute and activate emulsion, dispersion, and solution type polymer with viscosities up to 75,000 cps and active contents up to 75%, shall be provided. Systems without a proven track record with all types of polymers described

above will not be considered.

2. The liquid polymer activation chamber's mixing energy shall be staged such that it provides for high, non-damaging, mixing energy over the full operating range of the system which then dissipates through concentric chambers. The integral water control device, which shall also produce mixing energy by creating a pressure drop across its orifice, shall be constructed of stainless steel and brass and shall be designed to allow orifice replacement without disassembly of any other part of the system. The system shall be designed for use with either potable or non-potable dilution water.

3. A mixing chamber drain valve with 1/2" fitting shall be provided and plumbed to the nearest floor drain. The mixing chamber shall have a maximum rated pressure of 150 psi.

4. Provide a bronze, adjustable-range pressure relief valve on mixing chamber with a range of 50 to 175 psi.

5. At no time shall polymer be exposed to excessive shear. System's which are "retention time dependent", a system which is prone to induce insufficient or excessive mixing energy depending on flow rate and the subsequent retention time in the mixing chamber, or which utilize conventional static mixers, mixing blocks, eductors or flash mixers, shall not be considered. All components that require periodic maintenance shall be readily accessible.

B. CHECK VALVE

1. Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be designed with an open, unobstructed path to the valve seat. The valve body shall be constructed of Teflon and the ball shall be stainless steel. The valve shall be readily accessible for cleaning and shall be easily disassembled. Conventional check valves, or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted.

C. DILUATION WATER CONTROL

1. The dilution water flow rate shall be monitored by a Rotameter type flow meter. Unions shall be provided on the inlet and outlet of the Rotameter to allow easy removal for cleaning.
   a. Rotameter accuracy shall be 64% of full scale flow.
   b. Materials of Construction:
      1. Metering Tube: Machined Cast Acrylic
      2. Internal Components: 316L Stainless Steel
      3. Fitting: PVC
      4. Elastomers: Buna-N

2. Unit shall have an electric solenoid valve for on/off control of total dilution water flow.

3. The dilution water flow rate shall be manually adjusted through a flow control valve connected directly to the mixing chamber. Valve shall be

constructed of PVC body, SS needle, and SS seat.

4. Dilution water differential pressure shall be monitored by an industrial duty differential pressure switch rated NEMA 4X with a range of 0-90 psig. Pressure switches with plastic construction or fittings and mechanically actuated flow switches shall not be acceptable. Differential pressure switch shall be United Electric model J21K-16074 or equal.

D. PUMP

1. Unit shall have a neat polymer metering pump. Pump shall be a minimum two (2) stage positive displacement, progressing cavity type. Rotor shall be 316 SS. Stator shall be fluoroelastomer. Pump shall have a packing seal.

2. Pump shall be driven by a 1/4 HP (minimum), TEFC, 0-90 volt DC motor. Variable speed capability shall be provided by an SCR controller. Maximum speed of the pump shall not exceed 450 RPM.

3. Provide a metering pump calibration assembly rigidly mounted to the system frame and sized to provide a one-minute drawdown at 100% pump capacity. The column shall be graduated in increments of 0.1 gallons/10mL. Supporting the calibration column with the polymer piping is not acceptable.

E. CONTROLS

1. A control panel affixed to the system's frame shall be provided, rated NEMA 4X and constructed of FRP. The control panel shall consist of all switches, relays, indicator lights, digital displays, and controllers as required herein. The control panel components shall be NEMA 4X. All skid-mounted electrical components interconnected to control panel shall terminate on terminal blocks. Terminal blocks shall be sized for 14 ga. wire with terminal block numbers and a legend. Wires shall be neatly run through wire race-way and numbered with adhesive type labels.

2. Control Devices:
   a. Main Power/System ON-OFF–REMOTE selector switch, Allen Bradley 800H series or equal.
   b. Non-Fused type door mounted disconnect.
   c. NEMA 4X, panel-mounted, 10-turn potentiometer for local control of pump speed.

3. SCR Controller:
   a. Input Voltage: 115/230 VAC.
   b. Output Voltage: 0-90 VDC or 0-180 VDC.
   c. HP Rating: 1/8-1 @ 90 VDC, 1/4-2 @ 180 VDC.
   d. Signal Input: 4-20mA or 0-10VDC, selectable.
   e. Max Output Current: 10 Amps.
   f. Adjustable min speed, max speed, current limit, IR compensation, and signal input adjust.
   g. 3% linearity through 60:1 speed range.

4. Indicators:
   a. System running indicator: white full voltage pilot light, Allen Bradley

800H series or equivalent.
b. Low water differential pressure alarm.
c. LCD display of pump rate.

5. Inputs:
   a. 4-20mA metering pump pacing signal.
   b. Contact Closure (maintained) for remote starting/stopping of polymer system.

6. Outputs:
   a. System "Running" status output, dry contact.
   b. System in "Remote mode" status output, dry contact.
   c. Low Water Pressure Alarm, dry contact.

7. Alarms
   a. Loss of Dilution Water Flow Alarm, Differential Pressure Type. Metering pump goes to stand-by mode when low dilution water pressure occurs. The pump automatically restarts when pressure returns.

2.06 MAINTENANCE

A. Unit shall be open frame design to allow easy access to all components.

B. Mixing chamber shall be easily disassembled and reassembled to allow access to all parts exposed to neat polymer.

C. Polymer check valve shall be readily accessible. Check valves installed inside mixing chamber shall not be acceptable.

2.07 MATERIAL SPECIFICATIONS

A. Connections - Plumbing
   1. Dilution water inlet, 1" FNPT.
   2. Neat polymer inlet, 1" FNPT.
   3. Solution discharge, 1" FNPT.

B. Connections - Electrical
   1. 120/1/60, 15 amps max.
   2. Door-mounted rotary disconnect.
   3. Terminal blocks for interconnecting all skid-mounted electrical devices.
   4. Terminal blocks for all remote input and output signals.

C. Dimensions
   1. Frame, 24" wide x 24" deep x 68" high (62 x 62 x 175 cm).

D. Materials of Construction
   1. The system's frame shall be of rugged 304 stainless steel construction. No mild steel shall be used. The skid shall be constructed of 3/16" minimum 304 stainless steel. The frame shall be constructed of 3/16" angle or structural stainless steel tubing. The panel supporting the control panel shall be a minimum of 12 ga. Vertical frame members shall be gusseted. All pipe supports shall be stainless steel. The skid shall be designed for fork-lifting and

shall have holes for mounting to concrete pad. The systems frame shall be designed for an integral dilution water booster pump in the event the plant's water system is incapable of providing sufficient dilution water pressure. Maximum system dimensions shall be per schedule above. Control panel shall be mounted in vertical position and at 60" high. Pump suction shall not exceed 18" from the skid base.

2. Piping and valves shall be mounted with rigid pipe clamps. Fasteners required to mount components to system frame shall be minimum ¼-20.
3. Dilution water plumbing shall be schedule 80 PVC. Hose shall be braided vinyl. Hose fittings shall be schedule 80 PVC. No nylon fittings shall be used.
4. Mixing chamber – 304 stainless steel.

2.08 SPARE PARTS

A. Supply the following spare parts, one (1) per each system:
   1. Polymer check valve repair kit.
   2. Neat polymer pump spare parts kit for each pump supplied:
      a. Pump stator.
      b. Pump Rotor.
      c. Pump packing.

2.09 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be supplied. As a minimum, operation and maintenance manuals shall include:
   1. Principle of operation.
   2. Installation instructions.
   3. Description of unit and component parts.
   4. Operating procedures.
   5. Maintenance procedures.
   6. Safety precautions.

PART 3––EXECUTION

3.01 INSTALLATION

A. Contractor shall install the liquid polymer blending unit in accordance with the manufacturer's shop drawings and instructions.

B. Bolt skid unit to concrete pad using stainless steel anchor bolts/nuts (304) with a minimum of 4 or more as recommended by manufacturer. Include necessary vibration dampening.

3.02 MANUFACTURER'S SERVICES

A. Minimum service requirements:
   1. Certify proper installation prior to scheduling start up and functional testing.
   2. One eight-hour day on site for start-up, functional testing, and operator training.

END OF SECTION

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SOLID BOWL DECANTER CENTRIFUGE

SECTION 46 76 33

SOLID BOWL DECANTER CENTRIFUGE

PART 1 – GENERAL

1.01 SUMMARY

The contractor shall furnish and install the centrifuge and associated piping, valves, controls, and wiring as specified and shown on the drawings and as required to provide a complete installation. The centrifuge system specified in this section shall be provided by a single manufacturer to ensure coordination and compatibility of equipment. The contractor and manufacturer shall be responsible for insuring a complete and operable centrifuge system.

1.02 REFERENCES

A. The design, manufacture, and installation of this equipment shall meet or exceed the applicable provisions and recommendations of the following codes and standards:
   1. AGMA, American Gear Manufacturers Association.
   2. ASME, American Society of Mechanical Engineers.
   3. ASTM, American Society of Testing and Materials.
   4. ANSI, American National Standards Institute.
   5. IEEE, Institute of Electrical and Electronics Engineers.
   6. NEC, National Electrical Code.
   7. OSHA, Occupational Safety and Electrical Code.

1.03 DEFINITIONS

A. Solids Capture: Solids capture is defined as the percent of the total suspended solids content in the feed sludge that remain in the thickened or dewatered end product on a weight basis.
   1. For purposes of this specification, "Capture" is defined as:

% Capture= (C/F) [(F-E)/(C-E)] x 100%

Where:
C = Dewatered Sludge Total Solids (% TS)
F = Feed (% TSS); excluding any dilution from polymer solution flow
E = Filtrate (% TSS); excluding any dilution from polymer solution

B. Polymer Consumption: To be based on 100% active polymer.

1.04 SYSTEM DESCRIPTION

A. Performance Requirements: The centrifuge shall operate within the design conditions listed in part B "DESIGN CRITERIA" of this section 1.04 and meet the following performance criteria:

1.	Number of centrifuge(s)	1
2.	Maximum flow rate (GPM)	120
3.	Sludge hydraulic coding (gpm)	45
4.	Polymer dosage(lbs./ton)	10 to 25

B. Design Criteria: The centrifuge shall be designed to extract water from the sludge specified herein after conditioning of the sludge with a polymer solution. The process of dewatering shall produce a finished sludge product based on the following design requirements:

1.	Type of Sludge	Domestic
2.	Solids Concentrations (% TSS)	To be determined
3.	Solids Loading (TS/hour)	To be determined
4.	Unthickened solids concentration	1 percent
5.	Thickened solids concentration	3 percent
6.	Operating Cycle (hrs./day/week)	To be determined
7.	Sludge Volume Index (SVI)	To be determined

1.05 SUBMITTALS

A. Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, power drive assembly, parts, instrumentation devices, and other accessories forming a part of the equipment furnished shall be submitted for review. The following information shall also be submitted with shop drawings:

1. Detailed drawings and descriptions of all items of equipment, including centrifuge control panels, showing all dimensions, parts, construction details, and materials of construction signed and stamped by a professional engineer registered in the United States of America and South Carolina and directly employed by the centrifuge manufacturer.

2. Complete motor rating including all nameplate data; guaranteed minimum rated efficiency and speed torque curves.

3. Complete electrical system drawings and description including, but not limited to, the following:
   a. Complete system interconnection diagrams between power supply, control panels, drive motor, secondary drive motor, and all ancillary equipment connected to control system, including terminal number connection points.
   b. Control panel overall dimensions and layout of external and internal mounted components.
   c. Complete electrical schematics with power wiring and control wiring in accordance with current standards. Schematics shall include all component ratings.
   d. Description of control system in written form including functions monitored, controlled, and alarmed. Include sequence of operation and interface requirements.
   e. Control component itemized information and data.

4. Certified calculations of AFBMA L-10 bearing life.

5. Type of lubrication recommended for all equipment.

6. Information on field and installation requirements, including mounting and access requirements and total weight of each component and each complete assembly.

5. List of spare parts to be furnished.

8. Statement for machine warranties.

B. Four Owners Manuals. Operations and maintenance information and equipment maintenance summary sheets shall be furnished for the equipment specified herein.

1.06 QUALITY ASSURANCE

A. Other than the named suppliers, all bidders proposing equipment described herein, shall provide a detailed pre-qualification submittal package and it shall be approved no less than fifteen working days prior to bid opening which shall consist, at a minimum of all information, and details prescribed in Section 1.05 of this specification. Pre-approval by addendum is required to be considered as an acceptable qualified bidder.

B. If submitted equipment requires arrangement differing from that indicated on the drawings or specified, prepare and submit for review complete structural, mechanical, and electrical drawings and equipment lists showing all necessary changes and detailing all special features of equipment proposed with pre-qualification package required above. Any changes are at no additional compensation and the bidders shall be responsible for all necessary engineering costs for redesign by the Project Engineer.

C. Only those manufacturer's capable of providing evidence of a minimum of five years' experience in the manufacture and installation of the exact model proposed and ten North American operating installation references with a minimum of five years' operating history of the exact model proposed shall be considered.

1.07 DELIVERY, STORAGE, & HANDLING

A. Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.

B. Spare Parts
1. Pack in containers bearing labels clearly designating contents and pieces of equipment for which the part is intended. Each part shall be identified with a tag bearing its part number and a part description.
2. Delivered at same time as equipment.

C. Unloading and Storage of the Equipment
1. The contractor is responsible for the unloading and storage of the equipment.
2. Delivered at same time as equipment.
3. Storage of the centrifuge shall be in a dry building per ANDRITZ Separation Inc. instructions.
4. All products shall be properly insured.

1.08 CONDITIONS OF SERVICE

A. Equipment to be protected by a building, but access doors may be open. Equipment shall be in a near ocean environment and shall be protected

accordingly.

1.09 SEQUENCING AND SCHEDULING

Not used.

1.10 WARRANTY

A. The centrifuge manufacturer shall warrant the following components:
   1. The manufacturer shall warrant against any defects in material or workmanship to the centrifuge, the earliest to occur for a period of 18 months from date of delivery or 12 months from start-up, whichever is the later to occur.

   2. The manufacturer shall repair or replace any parts of the centrifuge system that are found to be defective in workmanship or materials during the warranty period, provided said equipment is operated in accordance with the manufacturer's written operating instructions. The Owner shall notify the manufacturer in writing within 30 days after such defect becomes apparent.

1.11 MAINTENANCE

A. Spare Parts: The following spare parts, items (1-2) are to be furnished with the unit or maintained in the manufacturer's inventory, to be available within five business days from receipt of accepted purchase order.
   1. One set of main bearings.
   2. One set of seals and O-rings.

B. At a minimum one set of the following listed tools shall be included with the centrifuge equipment.
   1. One set ball bearing extractor.
   2. One set needle bearing puller.
   3. One conveyor lifter.
   4. One T-handle screw.
   5. One socket wrench for lube nipple.
   6. Threaded rods sized for machine.
   7. Manual grease pumps.
   8. Lubricator extension.
   9. Lubricator CY419 and CY430.
   10. Lubricator extension with clamps.

PART 2 – MANUFACTURERS

2.01 GENERAL

The centrifuge system shall consist of a horizontal solid bowl, fitted with an inner contoured scroll conveyor, utilizing a cyclo gear speed inducer for changing the differential speed between the rotating bowl and scroll conveyor. Additional components included in this specification that are to be independently mounted include the control panel(s) and centrate deaerator. System shall include, as a minimum, all controls and instrumentation as specified herein and presented on the drawings. Materials and general design of the centrifuge systems shall be the manufacturer's standard, except as specified hereinafter.

2.02 MANUFACTURERS

A. The equipment furnished shall be the product of a manufacturer that has demonstrated previous successful operation of full-scale units in North America in an application similar to that specified.

B. The centrifuge systems shall be the ANDRITZ Model D4L or equivalent. Equipment layouts are based on this equipment. Manufacturers proposing "or equivalent" centrifuges must meet all technical and mechanical requirements as specified herein and must comply with the pre-approval requirements identified in Section 1.06 above. Any changes to the installation due to use of another manufacturer will be at the bidder's sole expense.

2.03 MATERIALS OF CONSTRUCTION

A. All wetted parts of the centrifuge contacted by process material shall be a minimum of 316 stainless steel except O-rings or abrasion-resistant materials. The O-rings shall be made of Buna-N Viton unless specific processes such as high temperature or food applications require alternate material. The centrifuge bowl shall be constructed of statically cast 316 or duplex stainless steel. The outer bowl cover shall be of reinforced fiberglass and of one-piece construction. The centrifuge conveyor shall be constructed of a minimum 316 or duplex stainless steel.

B. Miscellaneous hardware, including bolts, nuts, washers, and fastener clips, shall be ASTM A320, of 316L stainless steel.

C. No dissimilar metals shall be in direct contact unless properly electrically insulated with a 2 mm thick continuous neoprene gasket.

2.04 CENTRIFUGE EQUIPMENT DESCRIPTION

A. The centrifuge shall be of the solid bowl horizontal, continuous feed, scroll conveyor type. A high performance conveyor utilizing disc technology shall be provided to allow either counter current or co-current operation or both whichever the application requires. The centrifuge design shall limit air leakage into or from the body of the centrifuge by means of a sealed cover and by minimizing clearances between the feed tube and its housing. Each centrifuge shall be dynamically balanced prior to shipment and shall be designed such that operating noise levels

will not exceed 80 dBA at a 1 meter distance from the centrifuge, as measured at the factory with all inlets and outlet openings closed, and running without any process liquids.

2.05 COMPONENTS

A. BOWL

1. The centrifuge bowl shall consist of a horizontal cylindrical-conical assembly. To insure performance capabilities the minimum bowl diameter and length shall be 16.92 inches and 62.67 inches respectively. Proposed units with less than the specified bowl geometry shall not be acceptable. Maximum bowl speed shall be 3,600 RPM, driven by a 40 HP main drive, producing a gravitational force not less than 3,115 G's. The bowl shall be statically cast from 316L / duplex stainless steel. All welded joints shall be examined for cracks, porosity, or other defects by means of a liquid dye penetrate test. Bowl inspection report shall be supplied on request.

2. The front and rear bowl hubs shall be a minimum of 316 stainless steel, statically cast or fabricated from a solid piece of 316 stainless steel. The bowl shall be supported on a cylindrical roller bearing at both the feed and discharge ends of the machine. Each of which shall be fitted for convenient external, high speed grease lubrication.

3. The pond depth in the centrifuge bowl shall be adjustable through the use of adjustable weirs at the large diameter (front) end of the bowl where liquid is discharged. Pond depth adjustment by individually, specific dimensioned, interchangeable plate dams shall not be allowed. Cake solids shall be discharged from the small diameter (rear) end of the bowl, opposite from the liquid discharge.

4. The bowl shall be manufactured with longitudinal grooves integrally machined into the bowl wall that shall prevent circumferential slippage of the sedimented solids and provide for the formation of a protective cake solids layer. The bowl shall be warranted against wear for a period of up to 35,000 operating hours. Proposed equipment utilizing longitudal strips attached to the bowl wall in lieu of integrally machined grooves shall be provided with a spare bowl assembly complying with item five below. The dewatered cake shall be discharged from the bowl through multiple cake discharge ports spaced evenly around the diameter of the small diameter end of the bowl. The solids discharge ports shall utilize weight balanced, field replaceable, mechanically attached wear nozzles. Nozzles utilizing chemical bonding or metallic brazing attachment methods are not acceptable.

5. The bowl shall be dynamically, independently balanced to allow for exchange of a replacement bowl without need for balancing of the assembled rotating assembly.

B. SCROLL CONVEYOR

1. The centrifuge shall include a 316 stainless steel horizontal cylindrical-conical scroll conveyor supported by a spherical roller type thrust bearing at the

feed (front) end and ball type bearings internal of the gearbox cake discharge (rear) end and shall be equipped with helical, open design flights independently mounted concentrically within the centrifuge bowl. To insure maximum loading and dewatering efficiencies, solid, full-depth flight designs are not acceptable. Bearings shall be protected by seals and be provided with grease fittings for lubrication. To convey sedimented solids to discharge, the internal scroll conveyor shall rotate at a slight differential speed from the bowl. The scroll will be driven by a 10 HP non connected load, power generating, and alternating current back drive system.

2. Sludge feed shall be introduced to the bowl through a multi-port feed chamber fabricated within the body of the scroll conveyor which evenly distributes the feed into the rotating assembly. The feed chamber wall assemblies shall be protected from abrasion wear by flame sprayed tungsten carbide hard surfacing. Replaceable urethane and inverted type accelerators within the feed chamber are not acceptable. The sludge feed shall enter the bowl from the feed chamber through multiple sludge feed ports spaced evenly around the diameter of the feed chamber. The sludge feed ports shall utilize weight specific, mechanically attached, field replaceable wear nozzles. Nozzles utilizing chemical bonding or metallic brazing attachment methods to the scroll body are not acceptable.

3. The scroll conveyor edge and face of the flights shall be protected against abrasion with full flighting length, weight specific, sintered tungsten carbide tile insert. The tungsten carbide tile insert shall be attached to a 316 stainless steel backing plate and the backing plate shall be attached to the conveyor flight by an electric welding attachment procedure. To eliminate tile backing plate detachment from the mother flighting, the wear tile assemblies shall not extend more than 5/16" past the top of the mother flighting. Wear tile hardness shall meet or exceed 2500 Vickers hardness and pass the requirements of ASTM G-65 testing procedures. A 15,000 hour wear guarantee shall be provided for the wear tile assemblies. In lieu of the 15,000 hour wear guarantee a spare, replacement scroll may be provided. Partial flighting length tile assemblies and flame sprayed configurations are not acceptable.

4. Tile wear shall be monitored by means of visual inspection. Measurable wear to the outer tile edge tips and face shall indicate service schedules. Tile replacement shall be capable of being made in the field without creating unbalanced conditions by removal of the old assembly and welding a new assembly in place.

5. The centrifuge conveyor shall be removable without disconnection and displacement of the main drive, backdrive, or removal of the bowl from the unit's base framework.

6. The scroll shall be independently balanced at full operational speeds prior to shipment. Certification of the balancing procedure shall be provided from a professional engineer licensed in the United States of America. A verifiable scroll exchange and refurbishment program shall be provided to the end user as part of the centrifuge scope of supply. A verifiable reference that has benefited from the supplying manufacturer's scroll exchange program is

required for approval of the proposed centrifuge supplier for this project.

C. BOWL COVER

1. The outer cover shall be molded of fiber reinforced plastic (FRP) material. The outer cover shall be protected from abrasion in the solids discharge area by a stainless steel inner shroud designed to resist abrasion and prevent direct contact of material with the outer cover. The inner casing shall be a minimum of 0.5" thick stainless steel. The wetted interior surface of the shroud shall be coated with tungsten carbide wear surfaces. The solids discharge inner shroud shall be field removable without removal or displacement of any rotating assembly component.

2. The outer cover shall be bolted directly to the main frame of the centrifuge.

D. MAIN DRIVE MOTOR

1. The centrifuge shall be furnished complete with a main / bowl drive motor utilizing a V-belt drive system. The main drive motor is to be rated for continuous duty and to have a horsepower output sufficient for operating conditions of maximum bowl speed and sludge feed rate. The motor service factor is not to be used in determining a non-overload condition. The motor torque shall be adequate for all operating conditions.

2. The main drive motor shall be a minimum of 40 HP, 1800 RPM, 60 Hertz, 3 phase, 1.15 S.F. high efficiency design as manufactured by Baldor or equivalent.

3. The main drive motor shall include the following features:
   a. Frame motor
   b. TEFC
   c. Horizontal squirrel-cage type
   d. High efficiency
   e. Class F insulation
   f. 1.15 service factor
   g. Corrosion resistant rotor and stator
   h. Condensate drain
   i. Gasketed conduit box
   j. Low noise design
   k. Stainless steel nameplate
   l. Thermal switch

1. Sound level of the main drive motor not to exceed 80 dBA at a distance of one meter as measured at the factory with all inlet and outlet openings closed, and running without any process liquids.

2. For easy access the drive belts and sheaves shall be covered with a molded fiber reinforced plastic (FRP) material protective guard independent of the main centrifuge cover.

E. BACKDRIVE MOTOR

1. Each centrifuge shall be equipped with a backdrive system to allow the adjustment of the differential speed between the centrifuge bowl and conveyor during operation. The backdrive system shall utilize an AC/VFD arrangement meeting the following requirements:

2. The backdrive motor shall be a minimum of 10 HP, 1,750 RPM, 60 Hertz, 3 phase, 1.15 S.F. high efficiency design as manufactured by Baldor or equivalent.

3. The backdrive motor shall be mounted directly below and vertically in-line with the main drive motor. Due to space considerations, designs not utilizing a vertical in-line main and backdrive configuration will not be acceptable. Secondary or backdrive motors that operate as a connected load shall not be acceptable. Hydraulic backdrive shall not be acceptable.

4. The backdrive motor shall include the following features.
   a. NEMA frame motor
   b. TEFC
   c. Horizontal squirrel-cage type
   d. High efficiency
   e. Class F insulation
   f. 1.15 service factor
   g. Corrosion resistant rotor and stator
   h. Condensate drain
   i. Gasketed conduit box
   j. Low noise design
   k. Stainless steel nameplate
   l. Thermal switch

F. BASE

1. The centrifuge shall be supported on a fabricated carbon steel base mounted on vibration isolators. The vibration isolators shall be selected and provided by the manufacturer for the service required to isolate the centrifuge unit from the building structure. Isolators shall be specifically sized depending on bowl speed and service conditions so that they have a minimum dampening effect of 98 percent of all vibration loads in all directions. Machined surfaces shall be provided at all points where support loads are transferred to the base. Lifting holes in the base shall be provided as required for lifting of the base by overhead crane. Overall dimensions of the centrifuge shall not exceed 133 inches long by 43 inches wide by 59 inches tall. Total dry weight of the equipment shall be a minimum of 6,614 pounds.

2. Contractor shall also provide conveyor to move cake solid to container/hopper. Conveyor shall be compatible with centrifuge and of similar materials. Manufacturer shall concur in writing with conveyor and installation.

G. CHUTES & CONNECTIONS

1. Chutes to direct the flow of discharged cake solids out of the solids casing shall be supplied by the installing contractor and be connected to the centrifuge solids casing via a flexible coupling. A centrate chute shall be provided by the installing Contractor and directly coupled to the liquid outlet flange via a flexible coupling. All piping connections for the sludge feed slurry, wash water, polymer injection, cake solids and centrate discharge chute connections, shall be equipped with flexible sleeves fabricated from neoprene and designed such that no exterior loads are

transferred to the other equipment. The centrifuge manufacturer shall provide the above referenced flexible connectors. Contractor shall also provide a conveyor to move cake solids to a container/Hooper. Conveyor shall be compatible with centrifuge and or similar materials. Manufacture shall concur in writing with conveyor and installation.

H. FEED MANIFOLD

1. The centrifuge shall be equipped with 316L Stainless Steel manifold which shall contain a triple tap connector assembly supplied by the centrifuge manufacturer at the feed inlet providing for feed, polymer, sample, and wash water connections. Depending on site installation and application the installing contractor shall provide for alternate polymer injection points in the sludge feed piping as directed by the engineer or equipment manufacturer.
   a. Sludge feed tap - Shall be a 2 inch ANSI Standard Flange
   b. Sludge feed sample tap - Shall be a 1 inch female NPT with a 1 inch female full port 316L Stainless Steel ball valve for manual sampling
   c. Polymer feed tap - Shall be a 1 inch female NPT
   d. Wash water tap - Shall be a 1 inch female NPT with an electrically controlled solenoid valve
   e. The minimum feed pressure shall be 7.5 psi at the centrifuge.

I. SAMPLE TAPS:

1. Sample taps shall be provided by the installing contractor in the cake and discharge chutes addressed in paragraph G above. Sample collection points shall be oriented for easy access according to the installation site requirements.

J. MAIN CENTRIFUGE BEARINGS:

1. Two main bearings shall support the entire rotating assembly. Pillow block bearings shall be cylindrical roller, each of which shall be equipped with an external grease lubrication point. Bearings shall have an AFBMA L-10 life of 100,000 hours minimum.

K. SPEED REDUCER:

1. Each centrifuge shall be equipped with a Cyclo speed inducer unit which is used to achieve differential speed between the centrifuge bowl and conveyor. The speed inducer shall have a torque capacity to meet the expected service conditions and shall be capable of withstanding a 500 percent momentary overload and 150 percent intermittent overload. Torque overload control shall be provided to initiate centrifuge shutdown in the event of conveyor overload. Mechanical over torque protection devices are not acceptable. The centrifuge manufacturer shall select the reduction gear ratio as required for the solids to be handled and to be consistent with satisfactory operation. The gear unit shall be grease lubricated. All standard units shall be provided with seals of Nitrile-Butadiene-Rubber (NBR 3760). The power transmitting elements shall be made of bearing steel, hardened, tempered and ground. A reinforced fiberglass safety guard / cover shall be provided to cover the speed inducer. The speed inducer shall be independently balanced to allow speed inducer replacement without re-balancing of the rotating assembly. Hydraulic, Viscotherm / Rotodiff, Eddy Current, or gearboxes requiring external lubrication systems will not be acceptable.

L. MACHINE WIRING:

1. The centrifuge shall be supplied with the following NEMA 4X rated components: stainless steel terminal box, bearing temperature probes for the rotating assembly support bearings and vibration sensor. All components shall be wired complete to the terminal box excluding power leads for the centrifuge drive motors.

2. Wire runs from machine mounted electrical control components to the machine mounted terminal box shall be rigidly mounted to the centrifuge frame.

3. Main and backdrive motor field connections shall be flexible, meeting all applicable electrical codes and provided by the installing contractor.

M. FASTENERS:

1. All fasteners supplied with the centrifuge unit which are subject to contact with any process flow or cake discharge shall be 316 stainless steel.

N. ANCHOR BOLTS:

1. All anchor bolts and accessories necessary for equipment attachments and incorporation into the concrete supporting structure shall be supplied by the contractor, according to manufacturer's recommendations.

O. PAINT:

1. All carbon steel surfaces shall be painted / coated to a minimum of the following criteria.
   a. Minimum surface preparation of thorough removal of burrs, complying with SSPC-SP3 standards, sandblasting complying with SSPC-SP5 standards, and complete grease removal.

   b. A minimum coating of primer utilizing a two-part, zinc chromate epoxy, anti-rust primer meeting AFNOR: FAMILY I Class 6b requirements. Each coat shall have a dry film thickness of 2.5 to 3.0 mils.

   c. A minimum of one paint undercoat of epoxy, phenolic, polyamide coating meeting AFNOR FAMILY I Class 6b requirements with a minimum dry film thickness of 4 to 6 mils.

   d. One finish coat of epoxy, phenolic, polyamide coating meeting AFNOR FAMILY I Class 6b with a minimum dry film thickness of 4 to 6 mils.

   e. Total thickness of coatings must be a minimum dry film thickness of 12 mils.

2.06 INSTRUMENTATION AND CONTROL

A. GENERAL: The control system shall be complete with one industrial grade control panel. Centrifuge Control Panel (CCP).

B. CENTRIFUGE CONTROL PANEL (CCP)

1. The CCP shall be a NEMA 4X stainless steel, double door free standing enclosure with a side mounted air conditioner for the temperature and humidity control. The CCP shall be UL508A listed.

2. The CCP shall include a main circuit breaker with a disconnect handle that can be locked in the off position. The main circuit breaker shall be a 22,000 symmetrical amp thermal magnetic breaker sized in accordance with centrifuge system requirements.

3. Main control power components shall consist of variable frequency drive controllers with short-circuit and overload protection for bowl and scroll motors, power line reactor, DC buss fuses equipped with blown fuse switches and a control transformer.

4. Main Internal Control Components Shall Consist of: Programmable Logic Controller (PLC), surge suppressor, power supply, Ethernet switch, communications modem, control relays, and terminal points for interconnection with ancillary equipment.

5. Door mounted components shall consist of VFD interface keypads (one for each VFD) shall be door mounted for safe access to parameters while the panel is under power. This port shall limit maintenance personnel's exposure to arc flash dangers as detailed in NFPA 70E. NEMA 4X illuminated selector switch, mushroom head maintained emergency stop, NEMA 4X 120 VAC laptop receptacle with an Ethernet programming port, and a 10" color touch screen Operator Interface Terminal (OIT) NEMA 4X indoor rated. Third party controllers and interface units and European imports will not be allowed.

6. The CCP panel shall operate from a 480V AC, 3 phase.

7. Each Centrifuge VFD shall be Allen-Bradley 755 series.

8. The backdrive system shall provide for the regeneration of electrical power to the main drive motor as follows:
   a. The main drive motor and backdrive motor shall be electrically connected to a main and secondary variable frequency drive (VFD) at their respective AC circuit outputs.

   b. The positive and negative terminals of the DC circuits of both VFD's shall be electrically connected.

   c. The cycloidal properties of the speed reducer outlined in Paragraph 2.05.K of these specifications will allow the backdrive motor to function as a generator.

   d. The power generated by the backdrive motor shall be recovered by the secondary VFD and transmitted through the DC bus to the main VFD, thereby reducing power consumption from the outside grid.

e. The power generated by the backdrive motor shall allow for and provide flying restart capabilities. Drive designs that do not provide flying restart capabilities are not acceptable.

f. Backdrive systems which regenerate power to the outside grid shall not be acceptable due to higher overall power consumption.

g. Backdrive systems utilizing eddy current brakes, direct current or hydraulic drives are not acceptable.

9. The CCP shall comply with IEEE 519 at the point of common coupling.

10. The control transformer shall be sized for a minimum of 150 percent of the calculated load.

11. The PLC shall be Allen-Bradley CompactLogix. All control logic and algorithms shall reside within the PLC. Third party and proprietary controllers and interface devises will not be allowed. The PLC shall have adequate memory allowing 25 percent space for future program additions. The PLC shall be capable of interfacing directly with a plant SCADA system via Ethernet IP. An Ethernet switch with a minimum of two spare ports shall be provided for this connection. Contractor shall ensure that the PLC interferes with the plant SCADA. Coordinate accordingly.

12. The OIT shall be Allen-Bradley PanelView+CE with a minimum 10" screen measured diagonally or approved equal. The OIT shall communicate via Ethernet IP to the PLC. Third party and proprietary controllers and interface devises will not be allowed.

13. The OIT is a color display with touch sensitive technology and shall be 120 VAC. All operator functions and displays shall be provided with clear intuitive graphic touch cells and displays on the OIT.

14. The PLC shall be configured to accept process optimization code for future control upgrades.

15. An industrial din rail mounted Ethernet switch shall be provided with enough ports to link all required network connections. A minimum of one (1) spare port is required for future connections.

16. A door mounted maintenance interface port shall be provided to assist in programming and troubleshooting. This port shall limit maintenance personnel's exposure to arc flash dangers as detailed in NFPA 70E.

17. A backplane mounted elapsed time meter shall be provided for the main drive. As a minimum, a six digit, non-reset, register type with the last digit reading in tenths of an hour. Battery operated meter is not acceptable.

18. All components in the CCP shall be factory wired. All external control connection points shall terminate on terminal points. There shall be a minimum of 20 percent spare digital and analog inputs and outputs all factory wired from the I/O cards to its corresponding terminal strip.

19. Control wire shall be #16 AWG minimum, shall conform to UL standards, and shall be type THHN, THW or MTW.

20. A ground lug shall be supplied on the panel.

21. All customer interface contacts are provided through isolated 10 amp interposing relays. Contacts shall be suitable for 24 VDC or 120 VAC control.

22. Each wire segment shall be numbered at each end using white tubular heat shrinkable markers with black permanent mechanically stamped legends. The wire numbers shall correspond to those on the wiring diagram. Wrap around or clip type numbers are not acceptable.

23. Each internal component shall be labeled and shall agree with the wiring diagram. Letters shall be black on a white background to prevent obscuring text.

24. Field mounting of the control panel and interconnecting wiring and conduits between the centrifuge, operator panel, and starter panel shall be provided by the installing contractor.

25. A modem shall be installed capable of communicating directly with the PLC, OIT and VFDs for remote diagnosis and updates.

C. THE OIT SHALL AS A MINIMUM BE CAPABLE OF:

1. Automatic one touch starting and stopping.
   a. Including automatic torque control and conveyor/diverter gate operation based on operator settable parameters.

   b. Automatic status indication and individual component status.

   c. Auto start and stop adjustments shall be configurable via password protected operator inputs.
      1. Wake Mode - Defined as an early start feature in which the centrifuge will start, unattended, at a predetermined time before an operator starts his shift.
      2. Sleep Mode - Defined as an automatic shutdown feature that will shut down and flush out the centrifuge, unattended, at a predetermined time after an operator has ended his shift.

   d. Pause Mode
      1. Pause for process repairs
      2. Pause for Bin Removal

2. Manual stop and start operations and status of each individual system component.
   a. Status indication and control including.
      1. Centrifuge Start Stop
      2. Wash water valve
      3. Sludge pump
      4. Polymer pump

5. Conveyor forward and reverse

b. Safety interlocks shall remain active in manual mode.

3. Clean-in-Place (CIP) one touch starting and stopping.
   a. CIP status indication and individual component status.

   b. CIP adjustments shall be configurable via password protected operator inputs.

D. THE OIT SHALL BE CAPABLE OF DISPLAYING AND ADJUSTMENT OF ALL PERTINENT SYSTEM VARIABLES AND SETTINGS.
   1. Display of system variables
      a. Centrifuge drive motor amps and percent of full load
      b. Centrifuge bowl speed (Actual and Setpoint)
      c. Back drive speed (RPM) (Actual and Setpoint)
      d. Differential speed (Actual and Setpoint)
      e. Torque (Actual and Setpoint)
      f. Bearing temperatures
      g. Vibration
      h. Sludge flow rate
      i. Polymer flow rate
      j. Wake time
      k. Sleep time
   2. Display of all system related alarms
      a. Centrifuge shutdown alarms. When one of these alarms is triggered an automated stop shall be initiated.
         1. Main motor over temperature
         2. Main drive VFD fault
         3. High vibration
         4. Backdrive motor over temperature
         5. Backdrive VFD fault
         6. High Torque
         7. 3 STRIKES YOU'RE OUT alarm
         8. High feed end bearing temperature
         9. High drive end bearing temperature
         10. Cake discharge conveyor/ system fault

      b. Ancillary related alarms. A Pause shall be initiated stopping all process related equipment. Once the alarm has been cleared the operator shall be able to resume the process. If the operation has not been reestablished within an hour the centrifuge shall be forced into Auto Stop mode.
         1. Sludge related faults
         2. Polymer related faults

      c. Centrifuge 3 STRIKES YOU'RE OUT ALARM. This shall initiate a flush sequence. If three high vibration or high torque alarms occur within a ten-minute time limit an auto stop sequence will be initiated.
         1. High torque
         2. High vibration

d. Warning alarms. These will only set a warning horn and light but will not trigger any other actions.
   1. High drive end bearing temperature
   2. High feed end bearing temperature

3. Operator input control variables
   a. Centrifuge operation and processing
      1. Differential speed (Set point in RPM)
      2. Torque (Set point in percentage)
      3. Sludge flow (Set point in GPM)
      4. Polymer flow (Set point in GPH)
      5. Wake time (Set point in 24 hour format)
      6. Sleep time (Set point in 24 hour format)
   b. Operator input variables related to process and operations calculations.
      1. Sludge feed flow solids content (registered in percent total solids (% TS) and based on lab analysis of samples collected).
      2. Polymer make down dilution (registered in percent dilution of polymer by volume), ilf an automatic polymer dilution system is provided. The system shall provide the system shall provide the proper inputs / outputs to the CCP.
      3. Centrate solids content (registered in percent suspended solids (% TSS) and based on lab analysis of samples collected).
      4. Dry cake solids (registered in percent total solids (%) & based on lab analysis of samples collected).
   c. Sum of mathematical calculations for determining production and optimization.
      1. Sludge feed flow in GPM
      2. Sludge feed flow in GPD (To be automatically reset by internal clock at 12:00 am daily)
      3. Previous day total flow
      4. Gallons processed (Totalized) Wet pounds per hour
      5. Daily run time (To be automatically reset by internal clock at 0:00 daily)
      6. Run time totalized (Run time with sludge feed)
      7. Dry pounds per hour processed (Based on real time feed flow rates)
      8. Pounds per ton of polymer dosage (Based on real time polymer feed flow rates)
      9. Cubic yards of cake production per hour (Based on real time feed flow rates)
      10. Supervisor input system variables
      11. Capture Efficiency
   d. Supervisor input parameters (Password protected)
      01. Centrifuge bowl speed (Setpoint)
      02. Centrifuge configuration settings. (Machine specific)
      03. Alarm limits
      04. Scaling values
      05. CIP settings
      06. Torque PID settings

4. The centrifuge setup parameters shall be fully configurable from password protected screens including alarm set points, scaling variables, and CIP settings.

5. A screen shall be provided within the OIT to provide the operator with on-line help pages for each controlled device. The help pages shall include relevant flow charts and written descriptions as provided in the O&M manual.

6. A screen shall be provided to display the input and output statuses for both digital and analog signals of the PLC. This is to be used to limit maintenance personnel's exposure to arc flash dangers as detailed in NFPA 70E while performing trouble shooting duties.

E. INTERFACE REQUIREMENTS

1. Centrifuge Control Panel (CCP)

a. Power input from customer supply
   1. 460 VAC, 3 Phase, 60 HZ, 50 amps

b. Power output from CCP to motors
   1. Bowl drive motor
   2. Scroll drive motor

c. Inputs from Motors
   1. Bowl drive motor temperature switch
   2. Scroll drive motor temperature switch

d. Inputs to CCP from customer supplied equipment (digital)
   1. Polymer pump run confirm
   2. Polymer pump fault
   3. Sludge pump run confirm
   4. Sludge Pump fault
   5. Conveyor running forward
   6. Conveyor running reverse
   7. Conveyor overload signal

e. Inputs to CCP from machine junction box (Analog)
   1. Centrifuge vibration
   2. Drive end bearing temperature
   3. Feed end bearing temperature

f. Inputs to CCP from customer supplied equipment (Analog)
   1. Polymer pump flow and / or speed
   2. Sludge pump flow and / or speed

g. Outputs from CCP to customer supplied equipment (Digital)
   1. Polymer pump run command
   2. Sludge pump run command
   3. Cake conveyor run command forward
   4. Cake conveyor run command reverse

h. Outputs from CCP to field mounted devices

1. Wash water valve open command
2. Cake conveyor water valve open command

i. Outputs from CCP to field mounted devices (Analog)
1. Polymer pump speed setpoint
2. Sludge pump speed setpoint

F. DESCRIPTION OF OPERATION

1. CCP emergency stop shall de-energize the master control relay to interrupt all run commands for immediate shutdown. To restart system, the emergency stop(s) must be manually reset.

a. Starting and Stopping modes

1. On the "Main" screen select the system operating mode by touching one of the mode select touch zones. All equipment must be stopped to change modes; this will be indicated by the mode select enabled indicator.

2. Manual Mode – In this mode, system components shall be started with their respective start pushbuttons, which shall be accessed by touching the manual control touch zone that displays the "Manual Control" screen. Emergency stop will always stop all equipment. This mode of operation is provided for maintenance purposes only. (This mode is password protected).

3. Auto Mode – (Wake and Sleep Mode) in this mode, start-up and shutdown shall be controlled from the auto start/auto stop pushbuttons or Start-up shall be controlled from the "Wake Mode" screen by operator entering a predetermined time for system to begin process operation, up to a maximum of 24 hour delay. Auto start will initiate the sequence of events described below. At any time while in the Auto mode the operator can begin a start-up or shutdown. After a start-up has been completed the operator shall be capable of entering a shutdown time on the "Sleep Mode" screen to end a process run. At the end of the run time the control system will automatically begin a shutdown and cleaning cycle. The OIT shall display all automatic conditions and allow control of all time settings.

4. CIP Mode – Clean in pPlace (CIP). In this mode, start-up and shutdown shall be controlled from the CIP start/stop pushbuttons.

5. Pause Mode – Pause refers to the temporary stopping and starting of the process pumps etc. When a process alarm triggers or the Pause pushbutton is pressed the sludge and polymer will come to a stop. With a Bin change pause, the sludge and polymer shall stop, the wash water valve will open for a variable time to push the majority of the material out the solids end of the machine. Once the wash water de-energizes, spillage will be at a minimum allowing a cleaner

method of changing cake bins. In either case, depressing the Resume push button, the process pump shall restart at the last know settings.

b. The Auto Start cycle will initiate the following sequence of events
   1. Centrifuge bowl drive starts (instantly)
   2.
   3. Centrifuge back drive starts (three second delay from bowl starting)
   4. Polymer system starts (once bowl and back drive come to speed)
   5. Sludge feed pump starts (duration as set on "Setup 2" screen)
   6. Conveyor starts in reverse direction (instantly)
   7. Conveyor starts in forward (when torque is reached as on "Setup 2" screen)
   8. While Auto start is in progress the Auto start indicator light will flash "STARTING IN AUTO". After start-up is complete the indicator light will stay on steady "RUNNING IN AUTO".

c. The Auto Stop cycle will initiate the following sequence of events
   1. Sludge feed pump (instantly)
   2. Polymer system stops (instantly)
   3. Centrifuge goes to relative speed control (instantly)
   4. Centrifuge goes to auto stop preset speed #1 (at normal deceleration ramp)
   5. Wash water valve opens (once centrifuge is at preset speed #1)
   6. Centrifuge remains at this preset speed #1 (duration as set on "Setup 2" screen)
   7. Centrifuge goes to auto stop preset speed #2 (at normal deceleration ramp)
   8. Centrifuge remains at this preset speed #2 (duration as set on "Setup 2" screen)
   9. Centrifuge stops (at normal deceleration ramp)
   10. Wash water valve closes (at bowl speed set on "Setup 2" screen)
   11. The conveyor will stop once the purge cycle times out
   12. CIP will be initiated
   13. While Auto stop is in progress the Auto stop indicator light will flash "STOPPING IN AUTO" while in progress and go on steady "STOPPED IN AUTO" when complete.

d. CIP Mode – Clean in place (CIP). In this mode, start-up and shutdown shall be controlled from the CIP start/stop pushbuttons. Operating the CIP start pushbutton or an auto stop will initiate a CIP cycle as described below.
   1. Centrifuge bowl drive starts (instantly)

2. Centrifuge back drive starts (three second delay from bowl run confirm)
3. Wash water valve opens (instantly)
4. The duration and speeds for the CIP cycle are set on "Setup 2" screen.
5. Operating the CIP Stop pushbutton will initiate the following sequence of events.

e. Torque / Relative Speed Control – The centrifuge shall operate in two different control modes torque control (PI Auto) or relative speed control (PI manual). The active control mode is indicated below the centrifuge graphic on the main screen. To access control mode selection and setpoint entry, touch the centrifuge graphic, this will display the Torque control screen. The control mode is selected by touching either the Auto or Manual touch zones. Touching the numeric display of the current setpoint, which brings up a numeric entry keypad, enters the setpoint. The set point range is 0-100 percent * for Torque setpoint and 0-XX ** for Relative speed setpoint. This range can be limited to a maximum below 100 percent to prevent possible process upsets and equipment damage. This is configurable in the "system" setup.

f. Feed Control – Touching either pump graphic shall access the speed/flow setpoints for the polymer and sludge pumps. The "Polymer and Sludge Setup" screen will be displayed. Touching the numeric display below the word setpoint will bring up a numeric entry keypad. The setpoint range is 0-XXX GPM or GPH. This range can be limited to a maximum to prevent possible process upsets and equipment damage. This is configurable in the "system" setup screen.

g. Alarm Control – Alarm conditions shall be indicated with red background on the alarm screen and shall cause alarm horn to sound and beacon to flash. Alarm indicator will go on steady as long as condition is still in fault condition. Operating silence pushbutton will silence horn and cause indicator to flash only if condition has been cleared. Operating reset button will clear alarm indicator and allow system start-up. Normal none alarm condition shall be indicated by alarm indicator text in green. High vibration or high torque shall initiate a pause and flush sequence, Duration of the flush time shall be operator adjustable through touch screen. Once the high vibration or high torque alarm condition clears, feed to the centrifuge shall automatically resume. If three high vibration or high torque alarms occur within a ten-minute time limit, an auto stop sequence shall be initiated.

h. Passwords – The OIT shall be capable of storing several different passwords allowing access to several levels of operation or maintenance or adjustments. There shall be at a minimum four passwords. The passwords (numerical) shall be for the following, up to five different passwords can be provided for each level, exaccept the SYSTEM password. The OIT will retain the date and time and

password utilized for any of the password types below for up to ten entries.

1. System – The system password shall be the top level password known only by ANDRITZ. This password is to access manufacturer only areas of the OIT that allow for OEM set points and setup parameters to be maintained. The system password will be provided either after the warranty period or if a maintenance service contract is in affect once it has been expired. The system password once activated allows unrestricted movement through all of the OIT functions as described within the "PASSWORDS" area. The OIT will require a password re-entry if no activity is detecting after 15 minutes.
2. Operator – The operator password is required to operate the centrifuge and is for the most part a generic password. This password allows for Automatic operation of the centrifuge only. The operator is only able to make changes that affect the performance of the centrifuge such as flow, torque and polymer. The OIT will require a password re-entry if no activity is detected within 120 minutes. The requirement for an "OPERATOR" password can only be bypassed in the OEM setup parameters.
3. Maintenance – The maintenance password shall be provided to the owner for distribution as needed and allows for the full operation of the system in Automatic as described above for the "OPERATOR" level as well as being able to operate the system in "MANUAL" mode. The OIT will require a password re-entry if no activity is detected within 15 minutes. The requirement for a "MAINTENANCE" password can only be bypassed in the OEM setup parameters.
4. Lube Reset – The Lube Reset password shall be provided to the owner for distribution as needed and allows for the reset of the lubrication indicator for the Main Bearings. If the lube reset is not reset 10 hours after the prescribed time, the centrifuge will either automatically shut down or not start.

PART 3 – EXECUTION

3.01 EXECUTION

Install according to manufacturer's recommendations and requirements to provide a complete and fully functional system.

3.02 PREPARATION

Prepare equipment according to manufacturer's recommendations. Concrete pads on which equipment is placed upon shall cure 30 days prior to installing equipment.

3.03 ERECTION/INSTALLATION APPLICATION

A. Manufacturer's Representation for Start-Up and Testing

1. A manufacturer's technical representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for eight workdays (a workday is an eight hour period on site) for the services listed below. The following services shall be provided with allocation of workdays as established by the owner with the following distribution as a guide:
   a. Four workdays for onsite inspection, certification of installation and for pre-start-up classroom and onsite equipment instruction and maintenance training.

   b. Four workdays for start-up, functional and performance testing and for post-start-up classroom and onsite equipment instruction, troubleshooting, and other follow-up services.

B. Workdays shall be eight hour days, Monday through Friday, with dates determined by the Owner after a request by the contractor.

3.04 FIELD TESTS

A. Start Up Test: Testing shall be performed for each centrifuge installed. Prior to system start-up, system components shall be inspected for proper alignment, proper connection, and satisfactory operation. The Manufacturer's representative shall inspect installation, check for lubrication and minor adjustments, provide certification that the system components have been installed correctly and are ready for operation. The performance test shall not begin until start up testing has been completed to the Owner's and Engineer's satisfaction.

B. Commissioning
1. After start-up, the Manufacturer shall conduct a test using sludge to determine the actual system operating conditions and verify that the unit meets the minimum requirements specified herein.

2. Prior to these tests, the Manufacturer shall perform testing as necessary to determine and recommend the most effective type of polymer to produce the specified performance

.

3. The contractor, with the owner's help, shall provide sludge feed, water, electrical power, and sludge cake disposal necessary to conduct the performance tests. The polymers required shall be provided by the contractor at the recommendation of the centrifuge manufacturer.

4. The cost of laboratory testing necessary to confirm centrifuge performance for the initial test shall be borne by the Owner.

5. If, after a minimum of two four-hour test runs, with three rounds of sampling per run in the opinion of the Owner, the system meets the minimum performance requirements specified herein, the performance testing will commence.

6. In the case of non-acceptable performance, the manufacturer shall then have 60 days in which to perform at its sole expense, any supplemental

testing, equipment adjustments changes or additions and to perform a retest of the non-acceptable system.

C. Performance Testing

1. Testing shall be conducted during a seven day period to demonstrate the specified through put and that the unit process is met.

Standard Machine Cut Sheet

GENERAL MACHINE TECHNICAL DATA

Model Number	D4L
Diameter (Inches)	16.92
Maximum Operating Speed (R.P.M.)	3,600
Force (G)	3,115
Overall Length (Inches)	1343
Overall Width (Inches)	43
Overall Height (Inches)	59
Dry Weight (Lbs.)	6,614
Total Connected Load (HP)	40
Secondary Drive Motor (HP)	10 (not a connected load)

MAJOR COMPONENTS

A. Bowl
   1. Constructed of 316L / duplex stainless steel.

B. Bowl Cover
   1. Outer safety guard / enclosure constructed of reinforced fiberglass.

C. Cake Discharge
   1. Equipped with 316L stainless steel, field replaceable wear surfaces.

D. Casing

E. Scroll Conveyor
   1. Constructed of 316L stainless steel. The full length of flight edges protected against abrasion with field replaceable tungsten carbide tiles.

F. Internal Case
   1. Constructed of 316L stainless steel.

G. Base
   1. Fabricated of carbon steel mounted on vibration isolators.

H. Bearings
   1. All bearings L-10 rated for over 100,000 hours.

I. Fasteners
   1. Fasteners 316L stainless steel.

J. Gearbox
   1. In-line cyclo gear unit.

K. Control Panel
   1. NEMA 4X Centrifuge Control Panel

END OF SECTION