PROJECT MANUAL
FOR

SHENANDOAH WASTEWATER TREATMENT FACILITY IMPROVEMENTS

FOR

COWETA COUNTY WATER & SEWERAGE AUTHORITY NEWNAN, GEORGIA

COWETA COUNTY
WATER & SEWERAGE
AUTHORITY

PROJECT NO. 20518

GEORGIA
REGISTERED
No. 41549
PROFESSIONAL
12/07/22
ENGINEER
JARRED M. JACKSON

December 7, 2022

KREBS
ENGINEERING

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ADVERTISEMENT FOR BIDS

Sealed proposals will be received by the Coweta County Water & Sewerage Authority, until **10:00 AM Eastern Time** on **January 31, 2023**, for the construction of the **Shenandoah Wastewater Treatment Facility Improvements, Krebs Project No. 20518,** at which time and place they will be publicly opened and read.

A general summary of the work items is included below:

Improvements to the existing influent pump station, new headworks, new aeration blower/electrical building, new BNR aeration basin, improvements to the existing aeration basin (fine bubble diffusers, mixers, and BNR), new final clarifiers, new RAS/WAS pump station, additional (new) tertiary filters, new UV disinfection, new cascade (post) aeration, conversion of the existing final clarifiers to aerobic digesters, new solids handling facilities, chemical feed systems, miscellaneous yard piping, electrical, controls and SCADA improvements. This project is funded through GEFA; all pertinent federal requirements apply.

The work of constructing the project will be let under one Contract if an award should be made, and the Owner reserves the right to select the Bid considered by the Owner to be in the best interest of the Owner.

A cashier's check or bid bond payable to the **Coweta County Water & Sewerage Authority**, in an amount not less than five (5) percent of the amount of the bid, must accompany the bidder's proposal. Performance and Payment Bonds and evidence of insurance required in the bid documents will be required at the signing of the Contract.

Drawings and specifications may be examined at the office of the Engineer and at the Coweta County Water & Sewerage Authority.

Complete sets of electronic Bidding Documents are available for download through Quest Construction Data Network. The bidding documents are available at https://qcpi.questcdn.com/cdn/posting/?group=8009230&provider=8009230&projType=all and/or www.questcdn.com utilizing the Reference Quest Number 8350112. To be considered a plan holder, Bidders will be required to register with QuestCDN.com for a free regular membership and download the bidding documents for a $15 fee. Hard copies of the Bidding Documents are the responsibility of the Bidders. Contact QuestCDN at (952)-233-1632 or support@questcdn.com for assistance with navigating the website and digital project information.

For the duration of the advertisement period, a list of plan holders may be found at www.krebseng.com and QuestCDN.com.

Bids must be submitted on proposal forms furnished by the Engineer. All bidders bidding in amounts exceeding that established by the state licensing board for general contractors must be licensed under the appropriate/applicable provisions of state law, and must show evidence of license before bidding or bid will not be received or considered by the Engineer; the bidder shall show such evidence by clearly displaying his or her current license number on the outside of the sealed envelope in which the proposal is delivered. The Owner reserves the right to reject any or all proposals and to waive technical errors if, in the Owner's judgment, the best interest of the Owner will thereby be promoted.

OWNER
Coweta County Water & Sewerage Authority
545 Corinth Road
Newnan, GA 30263
(770) 254-3710

ENGINEER
Krebs Engineering, Inc.
15 LaGrange Street
Newnan, GA 30263
(470) 724-5050

INSTRUCTIONS TO BIDDERS

RECEIPT OF BIDS

Sealed Proposals will be received by the **Coweta County Water & Sewerage Authority, 545 Corinth Road, Newnan, GA 30263** where bids will be received until **January 31, 2023, at 10:00 AM, local time** for furnishing all labor, tools, materials, and equipment, and for doing the work of construction, according to the Contract Documents, as described in the Advertisement for Bids and in the Specifications, Drawings, and other Contract Documents. No bids will be received after the time set forth hereinabove, and the Proposals will be publicly opened and read aloud.

CONTRACT DOCUMENTS

Contract Documents are open for public inspection at the office of Krebs Engineering, Inc., **15 LaGrange Street, Newnan, GA 30263 and Coweta County Water & Sewerage Authority, 545 Corinth Road, Newnan, GA 30263**

Complete sets of electronic Bidding Documents are available for download through Quest Construction Data Network. The bidding documents are available at https://qcpi.questcdn.com/cdn/posting/?group=8009230&provider=8009230&projType=all and/or www.questcdn.com utilizing the Reference Quest Number 8350112. To be considered a plan holder, Bidders will be required to register with QuestCDN.com for a free regular membership and download the bidding documents for a $15 fee. Hard copies of the Bidding Documents are the responsibility of the Bidders. Contact QuestCDN at (952)-233-1632 or support@questcdn.com for assistance with navigating the website and digital project information.

DEFINITIONS

The following terms as used in these Contract Documents are respectively defined as follows:

(a)	"Contractor" or "Contractors":	The person, firm, or corporation signing the Contract with the Owner.
(b)	"Subcontractor":	One who contracts with the Contractor to perform all or any part of the Contract to be performed by the Contractor under the attached Documents.
(c)	"Work at Site of Project":	Work to be performed, including work normally done at the location of the project. See Article II of the Contract Agreement and Section 1.1 of the General Conditions.
(d)	"Purchaser, Owner, Authority":	Coweta County Water & Sewerage Authority
(e)	Engineer:	Krebs Engineering, Inc. or their duly authorized representative.
(f)	"Days":	Calendar days, unless otherwise specified.
(g)	"Proposal":	Wherever "Proposal" is used, it shall mean "Bid" and must be on the required Proposal Form.

PROPOSAL FORM

The Engineer will furnish Bidders with a Proposal Form. No bid will be considered unless submitted on the Proposal Form. The Bidders shall complete the Proposal Form in the manner prescribed, using ink for writing figures, or figures may be typed. The Bidder must sign the Bid correctly and legibly; and shall state his interest, title, or office in the company submitting the Bid. If the Bid should be made by an individual, his full name and address shall be shown; if made by a firm or partnership, the full name and address of each member of the firm or each partner shall be shown; and if made by a corporation, the full names and addresses of the president, secretary and treasurer shall be shown. Should the Proposal Form not be fully completed in ink by the Contractor, the Bid will be deemed to be informal and may be rejected.

The Proposal Form shall be fully completed in accordance with the Instruction to Bidders, in accordance with any instructions to bidders given in the Specifications (including the General Conditions), and without any excisions, alterations, special conditions or alterations made by the Bidder. The Bidder shall be fully responsive to all instructions relating to the Proposal.

OWNER PRE-PURCHASE EQUIPMENT

The OWNER has pre-selected the Biological Nutrient Removal System equipment, UV Disinfection System equipment, Dewatering System equipment and Biosolids Drying System equipment. The equipment manufacturers and pricing are listed on the Bid Proposal Form. The scope and supply and services to be provided by the equipment manufacturers are detailed in Specifications and the equipment proposals can be found in the Apendices. The bidder agrees that payment for the scope of equipment and services provided by the manufacturers as listed in the Bid Proposal Form shall be included in the Grand Total of the Bid.

The purchase order(s) will be transferred to the Contractor and become part of this Contract. Contractor shall be responsible for coordinating the submittals, fabrication, and shipping/handling and delivery, and shall also be responsible for installation of the materials/equipment. The Contractor shall include all associated costs, including, but not limited to receiving, handling, storage if required, and installation/start-up of material and equipment, in the Contract Sum unless specifically stated otherwise in the Contract Documents.

The warranty and payment terms for the pre-selected equipment (BNR System, Solids Dewatering System, Biosolids Drying System, and UV Disinfection System) may change as a result of project delays, Contractor preference, or other reasons. Additionally, each manufacturer may have excluded certain items from their scope, and other labor, materials, and/or appurtenances may be required for a complete system. The Contractor is solely responsible for furnishing and installing all labor, materials, and appurtenances and for negotiating any additional changes to scope (e.g., additional warranty time) and/or cost with each pre-selected manufacturer in order to ensure that the Owner receives a complete, functional system that complies with all aspects of the Contract Documents. All additional costs and/or costs for items not included in manufacturers' scope of work shall be included in the base bid cost to construct the project.

The Contractor shall be responsible for contacting each supplier, reviewing all terms and conditions, and the schedule(s) with the supplier. The Contractor, if he/she deems it necessary, shall then negotiate and include all additional costs and/or adjustments to the Terms and Conditions as required to complete the Work. The Contractor shall be solely responsible for additional costs associated with changes to the Terms and Conditions.

OWNER PRE-SELECTED SYSTEM INTEGRATOR

The Owner has standardized their SCADA/HMI programming requirements, SCADA PLC Hardware requirements, and maintains a professional services agreement with MR Systems. The scope and supply and services to be provided by the System Integrator is described in Appendix F and programming requirements are detailed in Specification Section 27 60 01. The bidder agrees that payment for the scope of system integration as listed in the Bid Proposal Form shall be included in the Grand Total of the Bid. The Owner specifying this SCADA programmer does not exempt the Contractor or SCADA PLC hardware integrator from meeting the Contract Documents requirements, nor does it give prior approval of subsystems, equipment, materials, or services. The SCADA PLC Hardware installation work is further described in project specifications Sections 276000 and 276005. The Contractor shall be responsible for coordination with the SCADA Programmer/Hardware Supplier/Installer.

BIDS

Bids shall be enclosed in a sealed envelope, endorsed **Shenandoah Wastewater Treatment Facility Improvements, Project Number 20518.**

The Bidder shall show, on the outside of the envelope and on the last page of the Proposal Form, the firm's Contractor's License Number for the State in which the project is located, and shall also show, on the outside of the envelope, firm's name and address.

No Bid will be received after the time specified in the Advertisement for Bids.

Any Bidder may withdraw the firm's bid, either personally, by email, or written request, at any time prior to the scheduled closing time for the receipt of bids.

No Bidder may withdraw the firm's bid for a period of sixty (60) days after the scheduled closing time for receipt of bids, as set forth in the Advertisement for Bids.

The Owner reserves the right to reject any or all bids, to waive any informalities in any bid, to select or reject Alternate Bid Items identified on the Proposal Form, and to accept any bid considered advantageous to the Owner.

A bid that has been sealed in its delivery envelope may be revised by writing a change in price on the outside of the envelope over the signature of the bidder or the bidder's "authorized representative". In revising the bid in this manner, the bidder must only write the amount of the change in price on the envelope and must not reveal the bid price, and must specify which item numbers on the Proposal Form are changed. An envelope change to a unit price proposal shall be specifically written in such a way as to alter one or more unit prices.

AWARD OF CONTRACT

The Contract, if awarded, will be awarded to the low, responsive, responsible bidder as soon as practicable, provided a satisfactory bid has been received. In order to be considered for the award of the Contract, the Bidder shall demonstrate to the Owner that he possesses all of the above named qualifications.

BID GUARANTY

Each Bidder must enclose with his Proposal a Bid Bond or a Cashier's Check drawn on a bank that is located in the same state as the project site, in the amount of not less than five percent

(5%) of the total bid. The payee of such bond or cashier's check shall be Coweta County Water & Sewerage Authority. The Bid Bond or Cashier's Check shall bear the same date as that set for the receipt of bids.

Bid Bonds shall be returned to all bidders, other than the low and two next low bidders, when the low bids have been determined. Those of the three low bidders will be returned after execution of the Contract.

If a bidder to whom a contract is awarded shall refuse or neglect to execute the Contract and furnish security in the amount required within ten (10) days after the notice has been given him of such award, his bid bond shall be forfeited to the Owner as liquidated damages for such refusal or neglect.

The successful bidder will be required to furnish, through an authorized agent in the state in which the project is located, a Performance Bond, Labor, and Material Payment Bond, Employer's Liability and Workmen Compensation Insurance, Comprehensive Liability Insurance, Property Insurance, Comprehensive Automobile Liability, Special Hazards or Perils and shall furnish proof of carriage of all of the above insurance all as set out in detail under "General Conditions" of the Specifications. The Performance Bond and the Labor and Material Payment Bond must be countersigned by an agent whose office is located in the state in which the project is located and who is authorized to do business in that state, and a valid Power-of-Attorney shall be attached to each Bond.

INTERPRETATIONS

If any person contemplating submitting a bid for the proposed contract is in doubt as to the true meaning of any part of the Contract Documents, he must submit a written request to the Engineer for interpretations thereof. The persons submitting the request will be responsible for its prompt delivery. Any interpretation of the proposed documents will be made by addendum duly issued, and a copy of such addendum will be mailed by certified mail (with return receipt requested) or delivered to each person receiving a set of such documents. The Owner will not be responsible for any other explanation or interpretation of the Contract Documents.

COMMENCEMENT AND COMPLETION OF WORK

Following the execution of the Contract by the Owner and the Contractor, the Contractor will be authorized to commence work by written Notice to Proceed from the Owner. The Contractor shall then commence work on the project within the time stated in the Contract, unless such time stated is extended by signed written agreement between the Owner and the Contractor, and shall fully complete all work under the Contract within the number of consecutive calendar days specified in the Contract.

FAMILIARITY WITH LAWS

The Bidder is assumed to have familiarized himself with all state laws and with all local ordinances and regulations which, in any manner, may affect the conduct of the work or those engaged or employed on the work, and no pleas of misunderstanding will be considered.

The attention of bidders is called to the provisions of state law governing general contractors, and bidders shall be governed by the provisions of said law insofar as it is applicable. The above mentioned provisions of the code make it illegal for the Owner to consider a bid from anyone who is not properly licensed under such code provisions. The Owner, therefore, will not consider any bid unless the bidder produces evidence that he is so licensed. Neither will the Owner enter into

a Contract with a foreign corporation which is not qualified under state law to do business in the state in which the project is located.

ASSIGNMENT OF CONTRACT

The Contractor shall not assign his Contract, nor any part thereof, nor any monies due, or to become due thereunder, without prior written consent of the Owner. In case the Contractor, with the consent of the Owner assigns all or any part of any monies due or to become due under this Contract, the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of the assignee in or to any monies due or to become due to the Contractor shall be subject to all claims, rights and remedies of the Owner, and all prior valid claims of all persons, firms, and corporation for services rendered or materials supplied for the performance of work under the Contract.

SUBCONTRACTING

No part of the Contract shall be sublet without the prior written consent of the Owner. The Contractor shall, following execution of the Contract, immediately submit to the Owner the names of subcontractors whom he/she proposes to employ on the project.

EXECUTION OF CONTRACT

The Contract Agreement/Documents shall be executed in triplicate, each counterpart of which shall be considered as an original without accounting for the absence of any of the other counterparts or copies.

QUALIFICATIONS OF BIDDERS

Bidders must meet the qualifications described in the Statement of Bidder Qualifications at the end of this section. Bidders must submit/include the Statement of Bidder Qualifications with their bid(s). Questions or clarifications regarding the Statement of Bidder Qualifications should be submitted in writing during the bid period.

The Contract award, if made, will be made to the low, responsive, responsible Bidder.

A responsive bid shall be evidenced by: (1), a Proposal Form completed in accordance with the Instructions to Bidders and with instructions and/or requests or directions contained in any other sections of the Contract Documents (including the Specifications and General Conditions); (2), a Proposal Form not evidencing any apparent unbalanced pricing for performance of the items of work; (3), a Proposal Form without excisions, alterations, special conditions or qualifications made by the Bidder; and, (4), a Proposal Form containing no alternative bids or offerings (by inclusion, attachment, or otherwise) for any items unless such alternative bids or offers are specifically requested in the Proposal Form and/or Contract Documents.

That a Bidder is responsible may be evidenced by the following facts: (1), that he maintains a permanent place of business; (2), that he has adequate financial capability for meeting the obligations contingent to the work; (3), that he has adequate forces to properly perform the work within the time limit specified; and (4), that he has a competent and experienced organization.

In order to be considered for the award the Bidder shall present to the Owner satisfactory evidence that: (1), he has the necessary capital and financial resources to undertake and complete the project; (2), he has equipment, in good working order, adequate for performance of work within the time specified; (3), he has within his organization, at the time of construction, management

and supervisory personnel available for assignment to the project; (4), the construction management and supervisory personnel are skilled and experienced in the particular type of work to be undertaken on the project; and (5), meets the requirements listed above.

STATEMENT OF BIDDER'S QUALIFICATIONS

The Bidder shall be one whose principal business and experience is similar to the work included in this project. The Bidder shall have successfully completed, under his/her present firm name, projects of similar size and scope. Similarly, the Project Manager and Superintendent to be assigned to this project must meet the following minimum requirements:

1. Minimum of 5 years of experience (in their current/respective role) with projects of similar size and scope.

Bidder must provide a Statement of Bidder Qualifications which includes clear and comprehensive responses to each item below. The statement must be signed by a legal representative of the Bidder and the signature must be notarized. The statement should be attached to this page. Failure to include a response to ALL items may result in the bid being considered non-responsive. Bidder may submit information in addition to the items below.

1. Name/address of firm/Bidder, date and location of organization/incorporation, and general description of work performed by your company.

2. List all projects within the past 5 years where the following occurred:

    - Bidder failed to complete any work awarded to you.
    - Bidder defaulted on a contract.
    - Bidder was assessed Liquidated Damages.
    - Bidder failed to complete the project by the Final Completion Date but negotiated to avoid Liquidated Damages (include a brief description, explanation, and project owner contact info.).

3. List and provide a brief description of recent projects of similar size and scope and include date and contact information for the project owner.

4. Provide name and a brief description of the experience of the Bidder’s proposed Superintendent, including date and project owner contact information for the current project on which he/she is assigned and for other projects of similar size and scope.

5. Provide name and a brief description of the experience of the Bidder’s proposed Project Manager, including date and project owner contact information for the current project on which he/she is assigned and for other projects of similar size and scope.

END OF SECTION

PROPOSAL FORM

MADE BY _____

ADDRESS _____

TO:

The undersigned, as Bidder, proposes and agrees, if this Bid is accepted, to enter into a Contract with **Coweta County Water & Sewerage Authority**, in the form of Contract specified and shown in the attached Contract Documents, to furnish all necessary materials, equipment, machinery, tools, apparatus, means of transportation, and labor necessary to complete the construction of the **Shenandoah Wastewater Treatment Facility Improvements, Project Number 20518** as described in the Advertisement for Bids, and in the Contract Documents, which are hereby referred to and made a part of the same extent as if fully set out herein, and in full and complete accordance with the shown, noted, described and reasonably intended requirements of the Contract Documents, to the full and entire satisfaction of the Owner, with a definite understanding that no money will be allowed for extra work except as set forth in the attached Instructions to Bidders, General Conditions, and other Contract Documents, based on the following pricing:

ITEM NO.	APPROX. QUANTITIES	DESCRIPTION OF ITEM	UNIT PRICE	TOTAL PRICE FOR ITEM
1	1	Mobilization/Demobilization Lump Sum		
2	1	**Shenandoah WWTF Improvements:** Furnish and install all labor, materials, equipment, and appurtenances for the construction of the WWTP improvements, site grading and storm sewer improvements, selective demolition, yard piping, existing influent pump station, new headworks, new BNR aeration basin, new aeration basin blower/electrical building, improvements to the existing aeration basin (fine bubble diffusers, mixers, and BNR), new final clarifiers, new RAS/WAS pump station, additional (new) tertiary filters, new UV disinfection, new tertiary disk filters, new cascade (post) aeration, conversion of the existing final clarifiers to aerobic digesters, new solids handling facilities, chemical feed systems, and all miscellaneous yard piping, and other associated improvements. Lump Sum		
3	1	**Electrical** Furnish and install all labor, materials, equipment, and appurtenances for the electrical improvements associated with the construction of the WWTF improvements. Lump Sum		
4	1	Owner pre-purchased Biological Nutrient Removal System, by **Xylem-Sanitaire** Lump Sum	$728,300	$728,300
5	1	Owner pre-purchased UV Disinfection System by **Trojan Technologies** Lump Sum	$603,110	$603,110
6	1	Owner pre-purchased Solids Dewatering System by **FKC Co., Ltd.** Lump Sum	$912,843	$912,843

ITEM NO.	APPROX. QUANTITIES	DESCRIPTION OF ITEM	UNIT PRICE	TOTAL PRICE FOR ITEM
7	1	Owner pre-purchased Solids Biosolids Drying System by **BCR Environmental Corp.** Lump Sum	$4,356,754	$4,356,754
8	1	SCADA PLC Programing by **MR Systems** Lump Sum		
9	1	SCADA PLC Equipment and Field Instruments Lump Sum		
10	3,000 SY	Asphalt Paving Section Per Square Yard		
11	9,600 SY	Mill and resurface existing Asphalt Paving Per Square Yard		
12	1,600 SY	Concrete Paving Section Per Square Yard		
			TOTAL PRICE FOR BASE BID $	

BASE BID: For construction complete as shown and specified in table above, the sum of

_____

Dollars

($_____).

ADDENDA: The Bidder acknowledges receipt of Addenda Nos. _____ , _____ , _____ , _____, _____, _____, _____ .

ALTERNATES: If alternates as set forth in the Contract Documents are accepted, the following adjustments are to be made to the Base Bid.

ITEM NO.	ALTERNATE DESCRIPTION	TOTAL ADD OR DEDUCT PRICE FOR ITEM
A1	Alternate to Furnish and Install base bid equivalent Tertiary Disk Filters – Circle one of the approved manufacturers below Five Star Filter Equipment equivalent Beacon Water Technologies equivalent Lump Sum	$

The award of the Contract will be based on the total/sum of the base bid price and the alternates (if any) selected by the Owner. The Owner will receive bids and all pricing will be read aloud, but the project will not be awarded until the bids are evaluated and a determination is made on which alternates are selected. Once the Alternates have been selected, the final bid amount will be calculated (base bid price plus adjustments for any alternate selected) for each bid submitted, and if an award is made, the project will be awarded to the responsive bidder with the lowest final bid amount.

The Bidder declares that he/she has examined the site of the work, and has familiarized himself/herself with the existing and proposed/new facilities (including the location, nature, sizes/dimensions, current and intended future use, etc.). The Bidder declares that he/she has fully informed himself/herself of conditions that would affect the proposed work, that, prior to the tender of his/her bid, he/she has examined the Contract Documents for the work and has read all special instructions and provisions contained in the Documents, and that he/she has satisfied himself/herself with respect to the quality and extent of work to be performed. The Bidder declares that the firm, the project manager and the superintendent are qualified and meet or exceed the experience requirements as outlined in the Instructions to Bidders and/or elsewhere in the Contract Documents.

The Bidder declares that he/she understands that, when quantities of work for which unit price bids are requested in the Proposal, such quantities are approximate only and are subject to either increase or decrease, that, should the quantities of any of the work items be increased, the Bidder proposes to perform the additional work at the unit prices bid by him, that, should the quantities of any of the work items be decreased, payment will be made only for the actual quantities of work performed and such payment will be based upon the unit prices bid by him/her, and that he/she shall make no claim for profits anticipated on the decrease in quantities of work. Actual quantities will be paid for as the work progresses, in accordance with the provisions of the Contract Agreement, and such quantities shall be subject to final measurements and determinations made upon completion of the work.

The Bidder understands that the Owner reserves the right, in the Owner's discretion, to reject any or all bids, to waive any informality in any bid, and to accept any bid considered to be advantageous to the Owner.

The Bidder agrees that his/her bid shall be valid for a period of sixty (60) calendar days after the date set for receipt of bids, and shall not be withdrawn for a period of sixty (60) calendar days after the date set for receipt of bids.

The Bidder has attached hereto a Bid Bond executed by a Surety Company authorized to do business in the state in which the project is located (with valid Power-of-Attorney attached), or a cashier's check drawn on a bank in the state in which the project is located, in favor of (made payable to) **Coweta County Water & Sewerage Authority**, the amount of 5% of the bid amount (total).

The Bidder agrees that, should he/she be notified that his/her Bid on the work has been accepted, he/she will, within ten (10) days from receipt of such notice, execute the formal Contract Agreement bound herein, and will furnish with the Contract evidence of Insurance Coverage of his/her construction operations and all of his/her operations associated with the project, all in accordance with the requirements of the General Conditions.

The Bidder further agrees that, in case of failure on his/her part to execute said Contract Agreement and to furnish all Bonds required by the Contract Documents, within ten (10) consecutive calendar days after receipt of notice of award of Contract to him, the monies payable to the Obligee of his/her Bid Bond, in accordance with the terms and conditions of the Bond, shall be paid to the Owner as liquidated damages for the delay and additional expense to the Owner caused by such failure on the part of the Bidder.

The Bidder hereby agrees that, should the work under the Contract be awarded to him/her, he/she will commence work under this Contract on or before a date to be specified in written "Notice to Proceed" given by the Owner, and that he/she will achieve Substantial Completion of the Contract within **670** consecutive calendar days following the Notice to Proceed, and will achieve Final Completion of the Contract within **730** consecutive calendar days following the Notice to Proceed. The Bidder agrees to pay, as liquidated damages, the sum of **$1,500** for each consecutive calendar day after the date set for Substantial Completion of the work until such time as Substantial Completion has been achieved. Once Substantial Completion has been achieved, the Bidder will not be assessed additional liquidated damages unless and until he/she fails to meet the Final Completion Date. If the Bidder fails to meet the Final Completion date, then he/she agrees to pay, as liquidated damages, the sum of **$1,500** for each consecutive calendar day after the date set for Final Completion of the work, all as provided in the General Conditions. At no time shall the Bidder pay more than **$1,500** per calendar day for liquidated damages. **The Bidder agrees that, once the Substantial and/or Final Completion dates have passed, the Owner/Engineer will begin deducting liquidated damages from the monthly progress payments.** The Bidder further agrees that he/she will not make any claim for extra compensation should completion of work under the Contract be affected in advance of the time specified hereinabove.

The undersigned Bidder states that he/she fully understands the meaning of "low, responsive, responsible Bidder", as defined in these Documents, and that these criteria will be applied in the evaluation of this Bid.

The undersigned, as Bidder, hereby declares that the name (or names) of the only person (or persons) interested in this Proposal, as principal (or principals), is (or are) as herein below set out and that no person other than that (or those) herein below stated has any interest in this Proposal, or in the Contract to be entered into; that this Proposal is made without connection with any other person, firm or corporation making a proposal; and that it is in all respect fair and in good faith, without collusion or fraud.

Following are the names and addresses of all persons, firms, and corporations interested in the foregoing bid:

_____

_____

_____
(Type or Print Name and Address of Firm)

_____
(Type or Print Contractor License No.)

_____
(Type or Print Name and Title of Officer/Legal Representative of Firm Submitting Bid)

_____
(Signature of Officer/Legal Representative of Firm Submitting Bid)

_____
(Type or Print Date)

NON-COLLUSIVE AFFIDAVIT

State of _____)

County of _____)

_____ being first duly sworn, deposes and says that:

(1) He is the _____, of
(Owner, Partner, Officer, Representative or Agent)

_____, the Bidder that has submitted the attached Bid;

(2) He is fully informed respecting the preparation and contents of the attached Bid and of all pertinent circumstances respecting such Bid;

(3) Such Bid is genuine and is not a collusive or sham Bid;

(4) Neither the said Bidder nor any of its officers, partners, owners, agents, representatives, employees or parties in interest, including this affiant, have in any way colluded, conspired, connived or agreed, directly or indirectly, with any other Bidder, firm, or person to submit a collusive or sham Bid in connection with the Work for which the attached Bid has been submitted; or to refrain from bidding in connection with such Work; or have in any manner, directly or indirectly, sought by agreement or collusion, or communication, or conference with any Bidder, firm, or person to fix the price or prices in the attached Bid or of any other Bidder, or to fix any overhead, profit, or cost elements of the Bid price or the Bid price of any other Bidder, or to secure through any collusion, conspiracy, connivance, or unlawful agreement any advantage against (Recipient), or any person interested in the proposed Work;

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

BY _____

_____
(Title)

Subscribed and sworn to before me

this ____ day of _____, 20__.

_____

_____

My commission expires _____

END OF SECTION

GEORGIA SECURITY AND IMMIGRATION COMPLIANCE AFFIDAVIT

State of _____)

County of _____)

_____ being first duly sworn, deposes and says that:

(1) He/She is the _____, of
(Owner, Partner, Officer, Representative or Agent)

_____, the Bidder that has submitted the attached Bid;

(2) By executing this affidavit, the undersigned contractor verifies its compliance with O.C.G.A. 13-10-91, stating affirmatively that the individual, firm, or corporation which is contracting with the Coweta County Water & Sewerage Authority has registered with and is participating in a federal work authorization program* [any of the electronic verification of work authorization programs operated by the United States Department of Homeland Security or any equivalent federal work authorization program operated by the United States Department of Homeland Security to verify information of newly hired employees, pursuant to the Immigration Reform and Control Act of 1986 (ICRA), P.L. 99-603], in accordance with the applicability provisions and deadlines established in O.C.G.A 13-10-91.

(3) The undersigned further agrees that, should it employ or contract with any subcontractor(s) in connection with the physical performance of services pursuant to this contract with the Coweta County Water & Sewerage Authority, contractor will secure from such subcontractor(s) similar verification of compliance with O.C.G.A. 13-10-91 on the Subcontractor Affidavit provided in Rule 300-10-01.08 or a substantially similar form. Contractor further agrees to maintain records of such compliance and provide a copy of each such verification to the Coweta County Water & Sewerage Authority at the time the subcontractor(s) is retained to perform such service.

_____
EEV/Basic Pilot Program* User Identification Number

_____
_____
BY: Authorized Officer or Agent Date
(Contractor Name)

_____
Title of Authorized Officer or Agent of Contractor

_____
Printed Name of Authorized Officer or Agent

SUBSCRIBED AND SWORN
BEFORE ME ON THIS THE
_____ _____DAY OF_____ _____, 20__.

_____
Notary Public
My Commission Expires:
_____

END OF SECTION

Affidavit of Compliance
Georgia State Revolving Loan Fund (SRF) Requirements

State of _____)

County of _____)

_____ being first duly sworn, deposes and says that:

(1) He/She is the _____, of
(Owner, Partner, Officer, Representative or Agent)

_____, the Bidder that has submitted the attached Bid;

(2) By executing this affidavit, the undersigned contractor verifies its compliance with all requirements of State of Georgia State Revolving Loan Fund (SRF) funding mechanism, stating affirmatively that the individual, firm, or corporation seeking to contract with the Coweta County Water & Sewerage Authority is familiar with all such requirements and provisions, including those specified by 1) Executive Order 11246; 2) Disadvantaged Business Enterprise (DBE) solicitation and utilization; 3) Davis Bacon and Related Acts; 4) Wage Rate Determinations for Heavy Construction in Coweta County, Georgia; and 5) is in compliance with same. Further, the undersigned contractor hereby certifies that the firm contracting with the Coweta County Water & Sewerage Authority will remain in compliance with all SRF requirements and provisions cited herein and throughout the Contract, whether or not said provisions are listed or described in the Contract Documents.

(3) The undersigned further agrees that, should it employ or contract with any subcontractor(s) in connection with the performance of services pursuant to this Contract with the Coweta County Water & Sewerage Authority, Contractor will secure from such subcontractor(s) similar verification of compliance with SRF funding on a substantially similar Subcontractor Affidavit form. Contractor further agrees to maintain records of such compliance and provide a copy of each such verification to the Coweta County Water & Sewerage Authority at the time the subcontractors are retained to perform such service.

_____ _____
BY: Authorized Officer or Agent Date
(Contractor Name)

_____
Title of Authorized Officer or Agent of Contractor

_____
Printed Name of Authorized Officer or Agent

SUBSCRIBED AND SWORN
BEFORE ME ON THIS THE
_____ _____DAY OF_____ _____, 20__.

_____
Notary Public
My Commission Expires:_____

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned,

as Principal _____ and

as Surety, are hereby held and firmly bound unto _____

Coweta County Water & Sewerage Authority

as Owner in the penal sum of _____

for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

Signed this _____ day of _____ , 20 _____

The condition of the above obligation is such that whereas the Principal submitted to _____ a certain Bid, attached hereto and hereby made a part hereof to enter into a contract in writing, for the _____

Shenandoah Wastewater Treatment Facility Improvements.

NOW, THEREFORE,

(a) If said Bid shall be rejected, or in the alternate,

(b) If said Bid shall be accepted and the Principal shall execute and deliver a contract in the Form of Contract attached hereto (properly completed in accordance with said Bid) and shall furnish a bond for his faithful performance of said contract, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said bid, then this obligation shall be void, otherwise the same shall remain in force and effect; it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety for value received, hereby stipulates and agrees that the obligations of said Surety and its bond shall be in no way impaired or affected by any extension of the time

within which the Owner may accept such Bid; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers the day and year first set forth above.

_____ (L.S.)
Principal

_____
Surety

By _____

SEAL

CONTRACT AGREEMENT

THIS AGREEMENT is made and entered into as of the _____ day of _____ in the year of 2023, by and between Coweta County Water & Sewerage Authority (the "Owner"), and _____ (the "Contractor").

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

Article I. **CONTRACT DOCUMENTS.** The Contract Documents shall consist of: this Agreement; the Contractor's Proposal on the required form; the General Conditions; the Performance Bond on the required form; the Labor and Material Payment Bond on the required form; all Addenda issued prior to the submittal of the Proposal; all Modifications issued, agreed upon, and signed by the Owner after the execution of this Agreement; and the Drawings (Plans) and Specifications as prepared by Krebs Engineering, Inc. (the "Engineer"), and as on file in the office of the Engineer. The documents enumerated above form the Contract and all are as fully a part of the Contract as if attached to this Agreement and fully set forth herein. The Contract Documents are sometimes collectively referenced as the "Contract," and any reference to the "Contract" in this Agreement and elsewhere in the Contract Documents includes all of the Contract Documents.

Article II. **SCOPE OF WORK.** The work to be done under this Contract by the Contractor, at his/her own cost, shall consist of furnishing all labor, materials, supplies, tools, documentation, facilities, transportation, services, testing, and equipment, and of performing all work, necessary to construct and fully complete the project entitled Shenandoah Wastewater Treatment Facility Improvements, Project Number 20518 all in accordance with the Drawings and Specifications and with the requirements and provisions of the Contract Documents. The Contractor's scope of work under this Contract is not limited merely to physical construction and related services, material, or equipment, but also includes the totality of all of the Contractor's obligations (*e.g.*, including insurance, indemnity, and warranty obligations) under or arising from any of the Contract Documents.

Article III. **TIME OF COMPLETION.** The work to be performed under this Contract shall be commenced within 10 calendar days after the date on which the Notice to Proceed is issued. The work shall be Substantially Complete within **670** calendar days after the date on which the Notice to Proceed is issued, and Final Completion of the work shall be achieved within **730** days after the date on which the Notice to Proceed is issued, subject, only to such extensions of time as may be expressly authorized by provisions of the Contract Documents.

Should the work under Contract not be fully completed within the times/dates specified, it is understood and agreed that the Contractor shall be liable to the Owner for liquidated damages, (to be deducted from the monthly/periodic and final estimates of work performed by the Contractor) computed at the rate of **$1,500.00** per day for each additional day required to achieve Substantial Completion of the work. Once Substantial Completion has been achieved, the Contractor will not be assessed additional liquidated damages unless and until he/she fails to meet the Final Completion Date. If the Contractor fails to meet the Final Completion date, then he/she agrees to pay, as liquidated damages, the sum of **$1,500.00** for each consecutive calendar day after the date set for Final Completion of the work. At no time shall the Contractor pay more than **$1,500.00** per calendar day for liquidated damages.

It is understood and agreed that these liquidated damages are not a penalty, but are to reimburse and compensate the Owner for the damages caused by the delay in the completion of the work, and that these liquidated damages may be deducted from the amounts otherwise payable to the Contractor or alternately may be recovered directly from the Contractor or its performance bond surety. It is also understood and agreed that, in the event that the work should be completed in advance of the completion date specified, the Contractor will make no claim for extra payment therefor.

Article IV. **CONTRACT PRICE.** The Owner shall pay the Contractor in full for performance of work under this Contract, in accordance with the price or prices set forth in the Proposal submitted by the Contractor, which Proposal made a part hereof to the same extent as if fully set out herein, but subject to such additions and deductions as expressly provided for in the Contract Documents, the sum of _____ (the "Contract Price" or "Contract Amount").

The Contract Price may be adjusted only as expressly provided in the Contract Documents.

Article V. **CHANGES IN WORK AND EXTRA WORK**. The Owner shall have the right to increase or decrease quantities of work, to make changes in the work, and to require the Contractor to perform extra work necessary for the satisfactory completion of the project.

Where new and/or additional items of work are found to be necessary for the satisfactory completion of the project, and where the character of the work is such that a reasonable price for the performance of the work cannot be established by use of contract prices or combinations thereof, such new and/or additional items of work shall be classed as Extra Work.

The procedure to be followed in such cases shall be in accordance with the provisions of the Articles of the General Conditions relating to CHANGES IN WORK, and PAYMENT FOR EXTRA WORK.

Article VI. **PROGRESS PAYMENTS.** The Owner shall make progress payments to the Contractor in amounts equal to values of work performed on the project through the closing dates of the preceding estimate periods, but less five percent (5%) of the combined values and less previous payments made. The retainage as set forth above shall be held until final completion and acceptance of the work. At the Owner's discretion, and when the work has reached substantial completion, as determined by the Engineer in accordance with the provisions of the Contract Documents, the retainage may be reduced to such an amount as would reasonably cover 150% of the cost of correction of items of work heretofore found to be faulty and the cost of work remaining to be done in order to effect the completion of all of the work in full accordance with the provisions of the Contract Documents. Progress payments will be made in accordance with the provisions of the General Conditions.

Article VII. **FINAL PAYMENT.** Final payment, constituting the entire balance of the Contract Price, shall be paid by the Owner to the Contractor within thirty days after the full completion and acceptance of the work and satisfaction of all conditions and requirements for final payment provided in the Contract Documents. The work will not be accepted until the Contractor has certified that he/she has completed all of the work in full accordance with the provisions of the Contract Documents, the Owner and the Engineer have completed the final review of the work and found that it appears to have been fully completed in accordance with the

provisions of the Contract Documents, the Contractor has advertised completion of the work in accordance with the General Conditions, and the Contractor has presented to the Owner satisfactory evidence that all indebtedness connected with the work has been fully paid and satisfied, all as set forth in the General Conditions.

Article VIII. **MISCELLANEOUS PROVISIONS.** Terms used in this Agreement which are defined in the General Conditions shall have the same meanings as designated in those component parts of the Contract Documents.

The Contract Documents, which constitute the entire agreement between the Owner and the Contractor are listed in Article I of this Agreement and, except for Modifications issued after the execution of this Agreement, are enumerated below. The signatures which appear hereunder shall have the same force and effect as if appearing on all of the Contract Documents enumerated as follows:

1. Contract Agreement Pages _____
2. Proposal Pages _____
3. General Conditions Pages _____
4. Supplementary Conditions Pages _____
5. Performance Bond Pages _____
6. Labor and Material Payment Bond Pages _____
7. Specifications Pages _____
   Sections _____
8. Drawings Sheets _____
9. Addenda (include date of addenda): _____
   _____
   _____
   _____

IN WITNESS HEREOF, the said Contractor has hereunder executed this Agreement by his/her signature shown hereon, and said Owner has hereunder executed this Agreement by affixing hereto his/her corporate seal and by signature of his/her corporate officer(s) as shown, on the date first written above, in 3 counterparts, each of which shall, without proof or accounting for the other counterparts, be deemed an original.

By signing this Agreement, the contracting parties affirm, for the duration of the Contract, that they will not violate federal immigration law or knowingly employ, hire for employment, or continue to employ an unauthorized alien within the state of Georgia. Furthermore, a contracting party found to be in violation of this provision shall be deemed in breach of the Contract and shall be responsible for all damages resulting therefrom.

CONTRACTOR

_____
(Print/Type Name of Firm)

_____
(Print/Type Name and Title of Officer/Legally Authorized Individual)

_____
(Signature of Officer/Legally Authorized Individual)

_____
(Print/Type Name of Attesting Witness)

_____
(Signature of Attesting Witness)

OWNER

_____
(Print/Type Name of Owner)

_____
(Print/Type Name and Title of Owner Representative)

_____
(Signature of Owner Representative)

_____
(Print/Type Name of Attesting Witness)

_____
(Signature of Attesting Witness)

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS that we _____ hereinafter called the Principal, and _____ hereinafter called the Surety, do acknowledge, ourselves to be held and firmly bound unto the Coweta County Water and Sewerage Authority hereinafter called the Owner, in the penal sum of _____ for payment of which sum well and truly to be made in lawful money of the United States, we bind ourselves, our successors, heirs, executors, administrators, assigns and personal representatives, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION OR BOND IS THIS:

Whereas the Principal has entered into a certain written contract with the Owner, bearing the date of _____, 20__ for the performance of the Shenandoah Wastewater Treatment Facility Improvements (the "Contract"), which is fully incorporated herein by reference, and made a part hereof to the same extent as if set out herein in full, and the Principal and Surety are and shall remain bound under this Bond for the full and faithful performance and satisfaction of all of the Principal's duties, undertakings, work, and obligations under the Contract,

NOW, THEREFORE, if the Principal shall well, truly and faithfully perform and satisfy all of his duties, undertakings, work, and obligations, all in accordance with the covenants, terms, conditions, agreements and provisions of the Contract, and if the Principal shall satisfy all claims and demands made or incurred under the Contract, shall fully correct all faulty work or defective work and make good any work that does not comply with the Principal's warranty and guaranty, shall fully indemnify and save harmless the Owner from all costs and damages whatsoever which the Owner may suffer by reason of any failure on the part of the Principal to do so, and shall fully reimburse and repay the Owner for any and all outlay, damage, and expense (including all additional engineering costs, all legal costs and attorney's fees) which the Owner may incur in making good any default or by reason of any failure by the Principal to fully perform and satisfy all of the Principal's duties, undertakings, work, and obligations under the Contract, then this obligation shall be void; otherwise, it shall remain in full force and effect.

Be it also understood that should the Principal be in default on or non-compliance with any of its obligations under the Contract, the Owner having performed the Owner's obligations thereunder, then upon written notice by the Owner to the Surety of such default or non-compliance, the Surety shall promptly:

(1) Remedy the default or non-compliance of the Principal, or

(2) Perform and satisfy all of the Principal's remaining work and obligations under the Contract in full accordance with the terms and conditions of the Contract, using for performance of such work a contractor chosen by the Surety and approved by the Owner, or

"Promptly", as used herein, shall be defined as within thirty (30) days from the date on which the Owner has notified the Surety in writing of the Principal's default on or non-compliance with the Contract.

Whichever method may be used by the Surety to remedy the Principal's default on or non-compliance with the Contract or to complete the work under the Contract and satisfy the Principal's obligations, the Surety shall also pay to the Owner all additional costs and damages incurred by the Owner by reason of the Principal's default on or non-compliance with the Contract and the subsequent completion of the work under the Contract by the Surety.

PROVIDED FURTHER, that the said Surety, for value received, hereby stipulates and agrees that no change, modification, extension of time, alteration, or addition to or of the terms of the Contract or to the work to be performed thereunder shall in any wise affect the obligation of the Surety under this Bond and the Surety does hereby waive notice of any such change, modification, extension of time, alteration, or addition to or of the terms of the Contract or to the work to be performed thereunder.

PROVIDED FURTHER, that final payment by the Owner to the Principal shall not abridge the rights of the Owner hereunder.

IN WITNESS WHEREOF, this instrument is executed in three (3) counterparts, each one of which shall, without proof of or accounting for the other counterparts, be deemed an original, on this day the _____ day of _____, 20__.

ATTEST:

By _____
(Principal Secretary)

_____
Principal

By _____

Title _____

_____

_____
Witness as to Principal

_____
Address

_____

_____
Address

_____
Surety

ATTEST:

By _____
(Surety Secretary)

By _____
Attorney-in-Fact

_____

_____
Address

_____
Witness to Surety

_____

_____
Address

Countersigned

_____
Resident Agent of Surety

_____

_____
Resident Agent Address

_____
Phone No.

LABOR AND MATERIAL PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, That we, _____hereinafter called the Principal, and _____ hereinafter called the Surety, do acknowledge ourselves to be held and firmly bound unto the Coweta County Water & Sewerage Authority hereinafter called the Owner, in the penal sum of _____ _____ for payment of which sum well and truly to be made in lawful money of the United States, we bind ourselves, our successors, heirs, executors, administrators, assigns and personal representatives, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION OR BOND IS THIS: WHEREAS, the Principal has entered into a certain written contract with the OWNER, bearing the date of _____, 2023 for the construction of Shenandoah Wastewater Treatment Facility Improvements a copy of which contract is attached hereto, incorporated herein by reference, and made a part of to the same extent as if set out herein in full, and the Principal and Surety are bound under this Bond which shall remain in full force and effect until all claims and demands with respect to labor and materials connected with the work under the contract have been satisfied, subject however to statutory limitations and to such other conditions as hereinafter stated.

NOW, THEREFORE, if the Principal and all Subcontractors to whom any portion of the work provided for in the contract is sublet, and all assignees of said Principal and said sub- contractors, shall promptly make payment to all persons, firms, subcontractors and corporations for furnishing said Principal and said Subcontractors with labor, materials, equipment, machinery, parts, fuel, foodstuffs, supplies, or repairs on machinery or equipment used in or incorporated in the work, for performing any work in connection with the prosecution of the work under the Contract, and under any modifications or extensions thereof, for all insurance premiums in connection with the work, for all labor performed in connection with the work whether by subcontractor or otherwise, or for reasonable attorney's fees incurred by any claimant or claimants in suits under this Bond, then this obligation shall be void; otherwise it shall remain in full force and effect.

PROVIDED FURTHER, that the said Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder or to the Specifications accompanying the same, shall in any wise affect the obligation of the Surety under this Bond, and the Surety does hereby waive notice of any such change, extension of time, or alteration or addition to the terms of the Contract or to the Specifications.

PROVIDED FURTHER, that this Bond is subject to the following limitations and conditions:

(a) Any person, firm or corporation who has furnished labor, materials, equipment, machinery, fuel, parts, foodstuffs, supplies, or repairs for machinery or equipment used or incorporated in the prosecution of the work under the Contract, or amendment or extension thereof, and who has not received due payment for furnishing such items, shall have a direct right of action in his or their name or names against the Principal and Surety on this Bond, which right of action shall be asserted in a proceeding instituted in a Court of competent jurisdiction in the area in which the work under the contract has been performed. Such right of

action shall be asserted in a proceeding brought in the name of the claimant for his or their use and benefit against said Principal or Surety, or either of them not later than one year after the final settlement of the contract, in which action such claim or claims shall be adjudicated and judgement thereon.

(b) In addition to any other legal mode of service, service of summons and other process in suits brought on this Bond may be had on the Principal or Surety by leaving a copy of the summons and complaint, or other pleading or process, with the _____ and the principal and the Surety agree to be bound by such mode of service above described, and consent that such service shall be the same as personal service on the Principal or Surety.

(c) The Surety shall not be liable hereunder for any damage or compensation recoverable under any workmen's compensation or employer's liability statute.

(d) In no event shall the Surety be liable for a greater sum than the penalty of this bond, or subject to any suit, action or proceeding thereon that is instituted later than one year after final settlement of the said Contract.

(e) No final settlement between the Owner and the Principal shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

IN WITNESS WHEREOF, this instrument is executed in three (3) counterparts, each one of which shall, without proof of or accounting for the other counterparts, be deemed an original, on this day the _____ day of _____, 2023.

ATTEST:

By _____
(Principal Secretary)

_____
Principal

By _____

Title _____

_____

_____
Witness as to Principal

_____
Address

_____
Address

_____
Surety

ATTEST:

By _____
(Surety Secretary)

By _____
Attorney-in-Fact

_____

_____
Address

_____
Witness to Surety

_____

_____
Address

Countersigned _____
Resident Agent of Surety

_____

_____
Resident Agent Address

_____
Phone No.

GENERAL CONDITIONS

1. WORK TO BE PERFORMED

1.1 The work to be performed under this Contract includes, without limitation, the furnishing of all materials, labor, tools, appliances, equipment, supplies, transportation, testing, inspections, documentation, facilities, and services necessary for the satisfactory completion, functioning as intended, and acceptance of all repairs, remediation, replacements, installations, improvements, and modifications described or required by any of the Contract Documents. The term "work" as used in these General Conditions and elsewhere in the Contract Documents, whether capitalized or not, is not limited merely to physical construction and related services, materials, or equipment, but also includes the totality of all of the Contractor's obligations (*e.g.*, including insurance, indemnity, and warranty obligations) under or arising from any of the Contract Documents.

1.2 The Contractor shall pay all sales, consumer, use and similar taxes for the work to be performed by the Contractor which are legally enacted when bids are received or negotiations concluded. The Contractor shall be solely responsible for determining whether the Owner is exempt from payment of sales and compensating use taxes (state and city/county) thereof on materials to be incorporated into the Work. If exempt, then the Owner will furnish the required certificates of tax exemption to the Contractor for use in the purchase of materials and equipment to be incorporated into the work. The Owner's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by the Contractor, or to materials and equipment not incorporated into the work. Except for materials covered by the Owner's tax exemption, the Contractor shall pay all sales, consumer, use, and similar taxes for the work.

2. CONTRACT DOCUMENTS

2.1 The Contract Documents form the Contract between the Owner and the Contractor. These documents supersede prior negotiations or agreements, either written or oral, and shall not be interpreted to create a contractual relationship between the Engineer and the Contractor, or between any persons or entities other than the Owner and the Contractor. The Contract Documents are the following:

A. The Contractor's Proposal submitted on the required Proposal Form.

B. The signed Contract Agreement between the Owner and the Contractor, and all documents it incorporates by reference. Execution of the Contract Agreement by the Contractor represents that the Contractor has visited and thoroughly investigated the site to become familiar with all conditions affecting the Contractor's performance of the work.

C. These General Conditions, which outline certain responsibilities and liabilities of the Owner and the Contractor and also the authority and responsibilities of the Engineer.

D. The Drawings (Plans) and Specifications, which show and describe the work to be performed. It is the intent of the Drawings and Specifications that the Contractor shall furnish all materials, labor, tools, appliances, equipment, supplies, transportation, testing, inspections, documentation, facilities, and services necessary for the proper execution of the work so shown or described so that it will

satisfactorily fulfill all of its intended purposes and functions. The Contractor shall execute all work so described in full conformance with the Drawings, Specifications, and all other Contract Documents; shall perform all incidental work necessary to complete the project in an acceptable manner; and shall fully, timely, and satisfactorily perform all obligations provided in any of the Contract Documents.

The Engineer shall be deemed the author of the Drawings and Specifications, including those in electronic format, and shall retain all reserved rights, including the copyright. The Contract Documents are for use solely with respect to this project, and shall not be used by the Contractor for any other purpose.

The Contract Documents shall be considered to be inseparable documents, and the Contractor shall use them in performing the work in accordance with their combined intent. Before submitting its Proposal, the Contractor shall thoroughly examine and compare all of the Contract Documents, and shall specifically notify the Engineer in writing of any perceived or suspected ambiguities, deficiencies, conflicts, or omissions within the Contract Documents. The Contractor waives any right or claim to any additional compensation or any time extension on account of any such ambiguity, conflict, deficiency, inconsistency, or omission if the Contractor fails to notify the Engineer of the same specifically and in writing before submitting the Contractor’s Proposal.

The Drawings and Specifications are intended to be complementary, and where work is called for in one but not in the other, it shall be performed as though it were specified or shown in both. Any seeming conflict between the Drawings, Specifications, and other Contract Documents, shall be submitted in writing to the Engineer as provided in the Contract Documents, and the Engineer's decision shall be final.

All actual or suspected discrepancies found between the Contract Documents and site conditions, and all actual or suspected inconsistencies or ambiguities within the Contract Documents, shall be immediately (and no later than three days after the discrepancy, inconsistency, or ambiguity is first discovered or suspected) reported in writing by the Contractor to the Engineer, who shall promptly respond in writing. After such discrepancies, inconsistencies, ambiguities are first discovered or suspected by the Contractor, any work done by the Contractor on any part of the project affected by such discrepancies, inconsistencies or ambiguities before receipt of written directions from the Engineer shall be at the Contractor's risk.

The figured dimensions and/or elevations shown on the Drawings shall be used by the Contractor for the layout of the work. Where the work of the Contractor is affected by finish dimensions, such dimensions shall be determined by the Contractor at the site of the work, and he shall assume the responsibility therefor.

The Owner reserves the right to amend or revise the Drawings or Specifications, and to furnish such other detail drawings as, in the opinion of the Engineer, may be necessary for the proper prosecution of the work. All such additional drawings or specifications shall have equal force and effect as the original Drawings and Specifications.

Except as provided for otherwise, or specified to the contrary, all copies of Contract Documents required for and necessary for the execution of the work will be furnished to the Contractor without charge.

E. Addenda to Contract Documents issued during the time of bidding (before receipt of bids) or forming a part of the Contract Documents issued to the Contractor for the preparation of the Proposal, shall be covered in the Proposal, and shall be a part of the Contract Documents. Receipt of each Addendum shall be acknowledged in the Proposal.

F. Performance and Payment Bonds furnished by the Contractor at the time of execution of the Contract Agreement, which shall be in the form prescribed by the Owner, and shall be with a surety authorized to do business in the state in which the project is located and countersigned by a resident agent of the surety in that state. Bonds shall be as follows:

1. Performance Bond in an amount equal to 100% of the Contract Amount as a guaranty of performance and satisfaction of all of the Contractor's obligations in accordance with the terms of the Contract Documents.

2. Labor and Material Payment Bond in an amount equal to 100% of the Contract Amount as a guaranty on the part of the Contractor to make all payments for labor, material, supplies, and equipment in connection with the Contract and the work.

G. Written modifications signed and issued after execution of the Contract Agreement, including, but not limited to, written amendments to the Contract, Change Orders, Construction Change Directives, and minor changes in the work issued by the Engineer.

3. INSURANCE

3.1 The Contractor shall not commence any work on the project until he obtains, at his/her own expense, all required insurance; and the Contractor shall not, at any time, conduct any operations on the project or associated with the project unless such operations are covered by the specified insurance. Such insurance must have the approval of the Owner as to limit, form, and scope of coverage. The Contractor shall not permit any subcontractor to commence work on the project until the same insurance requirements have been complied with by such subcontractor (or sub-subcontractors). The insurance coverage shall be maintained throughout the full period of the Contractor's performance of its obligations, including all times after final payment when the Contractor may be correcting, removing, or replacing faulty or defective work as a warranty or correction obligation, or otherwise, or returning to the site to conduct other tasks arising from the Contract Documents, and in addition, products and competed operations coverage shall be maintained for not less than five years after final payment. At the request of the Owner, the Contractor shall be required to submit insurance certificates after project completion showing that all insurance required to be maintained after project completion remains in place. The Contractor may use only insurers with a minimum A.M. Best rating of A-VII or better. All insurance policies shall include a waiver of subrogation in favor of the Owner and the Engineer.

3.2 As evidence of specified insurance coverage the Owner may, in lieu of receipt of actual policies, and at the Owner's sole option, accept certificates issued by the insurance carrier

showing such policies to be in force for the specified period, but the Owner may thereafter at any time require that the Contractor provide complete copies of the actual policies.

3.3 Nothing contained in these insurance requirements is to be construed as limiting the extent of the Contractor's responsibility for payment of damages resulting from his/her operations or performance under this Contract. The Contractor shall have responsibility to enforce subcontractor compliance with these insurance requirements.

3.4 The types of insurance that the Contractor shall be required to obtain and maintain are listed below:

A. Workmen's Compensation and Employer's Liability Insurance shall be in strict accordance with the requirements of the current and applicable Workmen's Compensation Laws of the state in which the project is located. The insurance shall cover all of the Contractor's employees employed or associated with the project; and where any part of the work is subcontracted, the Contractor shall require the subcontractor to provide similar Workmen's Compensation and Employer's Liability Insurance for all employees of the subcontractor unless such employees are covered by the protection afforded by the Contractor. In case any class of employees engaged in hazardous work under this Contract is not protected under the Workmen's Compensation Statute, the Contractor shall provide, and shall cause such subcontractor to provide, adequate coverage for the protection of all employees on the project not otherwise protected under applicable provisions of the statutes relating to Workmen's Compensation and Employer's Liability Insurance.

B. Comprehensive General Liability Insurance shall cover the Contractor and any subcontractors performing work under this Contract for any claims for bodily injury, for sickness or disease, for death, for personal injury, and for property damages which may arise either directly or indirectly out of, or in connection with, the performance of work under this Contract. The minimum limits of coverage shall be as follows:

Umbrella Liability $5,000,000 each occurrence, $5,000,000 aggregate
Bodily Injury $1,000,000 each occurrence, $2,000,000 aggregate
Property Damage $1,000,000 each occurrence, $2,000,000 aggregate
Personal Injury $250,000 each occurrence, $250,000 aggregate

The naming of minimum limits of coverage shall not be construed as limiting the Contractor's responsibility to provide contractual coverage sufficiently broad to ensure the provisions of the Article of these General Conditions relating to Indemnity, or limiting the responsibilities of the Contractor as outlined under the aforesaid Article.

Without limiting any of the above, the liability insurance coverage of the Contractor and its subcontractors shall include the following coverages and endorsements:

1. Products and completed operations coverage shall be maintained for five years after final payment. The Contractor shall furnish the Owner and each other Additional Insured evidence of continuation of such insurance at final payment and five years thereafter.

2. Blanket contractual liability coverage, to the fullest extent permitted by law, including, but not limited to, coverage of the Contractor’s contractual

indemnity obligations in Article 4 and elsewhere in the Contract Documents.

3. Broad form property damage coverage.
4. Severability of interest.
5. Underground, explosion, and collapse coverage.
6. Personal injury coverage.
7. Additional Insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.

C. Comprehensive Automobile Liability Insurance shall protect the Contractor and any subcontractor performing work under this Contract from any claims for bodily injury, for death, and for property damages which may arise either directly or indirectly out of, or in connection with, the performance of work under this Contract. The minimum limits of coverage shall be as follows:

Bodily Injury - $1,000,000 each occurrence, $1,000,000 aggregate
Property Damage - $1,000,000 each occurrence, $1,000,000 aggregate

The naming of minimum limits of coverage shall not be construed as limiting the Contractor's responsibility to provide contractual coverage sufficiently broad to ensure the provisions of the Article of these General Conditions relating to Indemnity, or limiting the responsibilities of the Contractor as outlined under the aforesaid Article.

D. Property Insurance shall afford protection against physical damage to property during performance of any of the Contractor’s obligations. Insurable portions of the project shall be covered on a completed value basis; and at any given time the dollar coverage provided shall be actual value of completed work, value of work in progress, and value of stored materials. The policy by its own terms or by endorsement shall specifically permit partial or beneficial occupancy or use prior to completion or acceptance of the entire work. This insurance shall include Builder's Risk "all risk" insurance, which shall include the Owner and the Contractor as named insureds, and all subcontractors as insureds or named insureds. Such insurance shall be written on a builder’s risk “all risk” policy form that shall at least include insurance for physical loss or damage to the work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire; lightning; windstorm; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; flood; collapse; explosion; debris removal; demolition occasioned by enforcement of laws and regulations; and water damage, If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; or flood, are not commercially available under builder’s risk policies, by endorsement or otherwise, then such insurance may be provided through other insurance policies acceptable to the Owner

E. Special Hazards or Perils. The Contractor’s Liability and Property Damage Insurance Coverage shall provide adequate protection against any death, any

bodily injury or any property damage resulting from the blasting operations in connection with the Contractor's work, or in connection with the work of his/her subcontractors.

Insurance carried by the Contractor on the insurable portions of the work shall not relieve the Contractor of the responsibility for the protection of all materials, equipment, work, and other property in the vicinity of the work until the project has been accepted by the Owner, and shall not limit the Contractor's liability for failure to do so. Any loss suffered on the project by reason of the perils named under Article 3.D. or under this sub-part of Article 3 shall be borne by the Contractor and the Insurance Company providing the coverage for the Contractor, and the Owner shall not be liable for any cost of replacement of lost or damaged work or material.

F. Contractor's Pollution Liability Insurance: The Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from the Contractor's operations and completed operations. This insurance shall be maintained for no less than three years after final payment.

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

H. Umbrella or Excess Liability Insurance: The Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability (including products completed operations), and automobile liability insurance described in the paragraphs above. Such coverage afforded shall follow form as to each and every one of the underlying policies. The coverage requirements for specific policies of insurance identified above must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

I. Notice of Cancellation or Change in Coverage. All policies of insurance required by this article shall 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 the Contractor and each Additional Insured. Within three days of receipt of any such written notice, the Contractor shall provide a copy of the notice to the Owner, the Engineer, and each other insured under the policy.

J. Protection of the Owner and the Engineer. The Contractor's commercial general liability, automobile liability, umbrella or excess, and pollution liability policies shall include and list as Additional Insureds the Owner and Engineer, and include coverage for their respective officers, directors, members, partners, employees, agents, consultants, and subcontractors; and the insurance afforded to these Additional Insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Coverage for Additional Insureds shall not be limited to claims, suits, damages, or liabilities caused be the sole negligence of the Contractor and shall include coverage for all claims, suits, damages, and liabilities that result in whole or in part from any act or omission of the Contractor, any of the Contractor's subcontractors or suppliers, or any other person or entities for whose acts or omissions any of them is or may be responsible. The Contractor shall obtain all necessary endorsements to support these requirements.

In the event that the Contractor or his/her Surety is prevented by law or by charter from naming the Owner and his/her agents, and the Engineer, as insureds in the policies providing the coverages listed under this Article, the Contractor shall purchase and maintain during the life of this agreement Owner's & Contractor's Protective Liability Insurance in amount of not less than $1,000,000.00; and the Additional Insureds shall be the Owner, the Engineer, and their respective agents and employees. The insurance shall protect the Owner, the Engineer, and their respective agents and employees from any claim or loss arising in whole or in part from any act of the Contractor or his/her subcontractors, or any failure to act on the part of the Contractor or his/her subcontractors, during the performance of work under this Contract.

4. INDEMNIFICATION

4.1 To the fullest extent permitted by law, and in addition to any other obligations of the Contractor under the Contract Documents or otherwise, the Contractor shall defend, indemnify, and hold harmless the Owner and the Engineer, and their respective officers, directors, members, partners, employees, and agents (collectively, the “Indemnitees”) from and against all claims, suits, demands, liabilities, judgments, 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) (collectively, “Indemnified Losses”) arising out of or relating to the performance of the work, including any work performed or undertaken by 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 responsible. The Contractor’s obligations to defend, indemnify, and hold harmless the Indemnitees shall not be excused solely because the negligence or other breach of a legal duty by an Indemnitee also caused or contributed to the Indemnified Loss, but the Contractor’s indemnification obligation to an Indemnitee may be proportionately reduced to the proportionate extent that the Indemnified Loss is adjudicated to have been caused solely by the independent negligent acts or omissions of such Indemnitee.

5. PATENTS AND ROYALTIES

5.1 The Contractor shall pay the costs of all royalties, license fees and patent fees involved by use, or manner of use in the work, of all designs, devices, materials, equipment or processes, and the Contractor shall provide for such use or manner of use by legal agreement with the owner of the patent or a duly authorized licensee of such owner. All such costs referred to hereinabove shall be included in the price bid for the work under this Contract.

5.2 The Contractor shall save harmless the Owner and the Engineer from any and all loss or expense by reason of use, or manner of use, in the work of any design, device, material, equipment or process covered by letter of patent or copyright; and the Contractor shall defend all suits resulting from claims for royalties, license fees or patent fees on designs, devices, materials, equipment or processes purchased by the Contractor for use in the work, and from claims for royalties, license fees or patent fees involved by use, or manner of use, of such items by the Owner.

6. LICENSES AND PERMITS

6.1 All licenses, fees, inspections and permits necessary for the prosecution of the work shall be secured and paid for by the Contractor at no expense to the Owner other than as reflected in the price bid for the work.

7. COMPLIANCE WITH LAWS, ORDINANCES AND REGULATIONS

7.1 The Contractor shall comply with all Federal, State, and Local laws, ordinances and regulations which in any manner affect the work or the conduct of the work, and shall comply with all orders and decrees as may have been adopted or as may be enacted by bodies or tribunals having any legal jurisdiction or authority over the work. The Contractor shall maintain all documentation, file all reports, and give all notices as required for compliance with the above. The Contractor shall defend, indemnify and save harmless the Owner and the Engineer against any suits or actions of any kind or nature brought, or which may be brought, against them for any claim or liability arising from or based upon the violation of any such laws, ordinances, work regulations, safety and health regulations, orders or decrees by the Contractor, his/her subcontractors, his/her suppliers, his/her agents, his/her representatives, his/her employees, or employees of his/her subcontractors or suppliers.

7.2 By signing this Contract, the contracting parties affirm, for the duration of the Contract, that they will not violate federal immigration law or knowingly employ, hire for employment or continue to employ an unauthorized alien within the state of Georgia. Furthermore, a contracting party found to be in violation of this provision shall be deemed in breach of the agreement and shall be responsible for all damages resulting therefrom.

8. SAFETY

8.1 The Contractor, in the prosecution of his/her work under the Contract, is bound by the requirements of "Safety and Health Regulations for Construction" of the Occupational Safety and Health Administration, U.S. Government Department of Labor, and of other authorities having jurisdiction in safety matters.

8.2 Under the terms and conditions of this Contract, the Engineer shall not act as Safety Supervisor for the Contractor, since such responsibility remains solely with the Contractor. The Engineer shall not be responsible for establishing safety practices or for prescribing safety measures for the Contractor.

8.3 The Contractor is solely and completely responsible for conditions of the work site, including safety of all persons and property affected directly or indirectly by his/her operations during the performance of the work; and this requirement is not limited in application to normal working hours, but applies continuously twenty-four (24) hours per day until final payment, and thereafter at any time the Contractor (or any of his/her subcontractors or suppliers) are present at the site of the work to perform continuing obligations of the Contractor.

8.4 The Engineer’s duty to the Owner to review the work in order to determine its acceptability in accordance with the Contract Documents and to conduct construction review of the Contractor's performance for the benefit of the Owner, shall not be construed as a duty to review the adequacy of the Contractor's safety measures on or near the construction site and/or to direct the actions of the Contractor's employees in the performance of the work as such duties are not included among the responsibilities of the Engineer.

9. WARNING SIGNS AND BARRICADES

9.1 The provision by the Contractor of warning signs, warning lights, barricades and watchmen is subject to the requirements of "Safety and Health Regulations for Construction" of the Occupational Safety and Health Administration, U.S. Government Department of Labor, of the State "Manual on Uniform Traffic Control Devices for Streets and Highways," and of other authorities having jurisdiction in the areas of safety and traffic control. The Contractor is solely responsible for satisfying the safety and traffic control requirements of authorities concerned with or affected by this work.

10. PUBLIC CONVENIENCE

10.1 The Contractor is required to conduct his/her work as to ensure the least possible obstruction to traffic, to ensure the least possible inconvenience to the Owner and the general public and the residents in the vicinity of the work, and to ensure the protection of persons and property. Permission of the proper authority is required before any road or street is closed to the public. The maintenance of accessibility of fire-fighting equipment to fire hydrants and to such areas as are necessary for the provision of fire protection is a requirement of the Fire Department of the authority having jurisdiction. The provision of temporary measures as required to ensure the safe use of sidewalks and streets by the public is the responsibility of the Contractor. The proper functioning of all gutters, sewer inlets, drainage ditches and irrigation ditches is to be ensured by constant clean-up along with the work and by provision of temporary facilities where required for the maintenance of natural surface drainage. The implementation of all such maintenance measures and safety precautions is the sole responsibility of the Contractor.

11. SANITARY PROVISIONS

11.1 The Contractor is responsible for the maintenance of proper sanitary conditions in the area of his/her work. The provision and maintenance of such sanitary accommodations as may be required for the use of his/her employees and of his/her subcontractor's employees is subject to the Rules and Regulations of the State Board of Health and to all local Codes and Ordinances. Refer to Article 7.

12. EXISTING CONSTRUCTION AND FACILITIES

12.1 Where work under this Contract is adjacent to or crosses highways, railroads, streets, roads, access facilities, or utilities under the jurisdiction of State, County, City or other public agency, public utility or private entity, the Contractor is required to secure written permission from the proper authority and to furnish such bond (cash or surety as required), or insurance agreement as may be required before executing such construction work. A copy of the written permission and bond or insurance agreement (when required) must be filed with the Owner before any work is done. The Contractor is responsible for the replacement and repair of all existing construction, utilities, equipment, and facilities of the Owner or others that are damaged in the execution of work under this Contract. The Contractor will be required to furnish releases from all authorities affected by the work before final acceptance of the work under this Contract.

12.2 The type, size and physical location of existing facilities are shown from available records and the accuracy of said information is not guaranteed. The Contractor shall make additional investigations as needed to verify type, size and physical location. These investigations shall include, but are not limited to, site visits, pot-holing/location, exploratory drilling/geotechnical work, discussions with Owner personnel, and review of site records/record drawings. These investigations shall occur prior to bidding the work,

and prior to development of submittals/ordering equipment and materials, and prior to beginning work. The Contractor shall assume all risks arising from, or out of, performing work in the vicinity of existing facilities, or connection to existing facilities.

13. COMMENCEMENT, PROSECUTION, AND COMPLETION OF THE WORK

13.1 Following the execution of the Contract by the Owner and the Contractor, a written Notice to Proceed will be given to the Contractor by the Owner. The Contractor shall commence work on the project in good faith within the number of days specified in the Contract Agreement; and the Contractor, in accordance with the terms and provisions of the Contract Agreement, will be required to prosecute the work in such a manner and with such forces as will enable him/her to secure the satisfactory completion of the work within the time period stated in the Contract Agreement.

13.2 The time allowed for commencement of the work shall be the number of consecutive calendar days specified in the Proposal and in the Contract Agreement; and the number of days shall be reckoned from the date of the Notice to Proceed. The time allowed for the completion of the work shall be the number of consecutive calendar days as specified in the Contract Agreement; and the number of days shall be reckoned from the date specified in the Notice to Proceed for commencement of work.

13.3 Should the work under this Contract not be completed within the time specified, it is understood and agreed that the Contractor shall be liable for liquidated damages computed at the rate per day as shown in the Contract Agreement, beginning from the stated date of completion and extending to the date of final acceptance of the work. Such liquidated damages may be deducted from the Contractor's monthly or final estimates, or may be recovered directly from the Contractor and its performance bond surety. It is understood and agreed that the liquidated damages are not a penalty, but are instead money due to compensate and reimburse the Owner for the extra costs and expenses and other losses caused by the delay in the completion of the work. It is also understood and agreed that, in the event that the work should be completed in advance of the scheduled date of completion, the Contractor will make no claim for extra payment therefor. The remedies provided above do not limit, and are without prejudice to, the Owner's rights to declare the Contractor in default for failure to make satisfactory progress and to make demand upon the Contractor's surety under the performance bond.

13.4 The Owner may grant an extension of time for completion of the work when prosecution of the work is unavoidably delayed or halted by occurrences that are entirely beyond the control of Contractor or its subcontractors or suppliers, including unjustified actions by the Owner, fire, or other catastrophes, but the Contractor shall not be entitled to any extension of time unless the Contractor shall, within seven days after the first occurrence of any of the conditions resulting in the delay, give written notice to the Engineer of the cause of the delay and its probable effect on progress of the entire work.

13.5 Abnormally adverse weather conditions that are more severe than could have been anticipated for the locality of the work during any given month may entitle the Contractor to an extension of the time for completion, but only if:

(1) the abnormal weather conditions had an unavoidable adverse effect on work scheduled to be performed when the adverse weather occurred, and which in reasonable and scheduled sequence would necessarily delay completion of the entire work, and

(2) the Contractor shall, within ten days after the end of the month in which the delay occurs, give the Engineer specific written notice of the delay caused by abnormal adverse weather that occurred during that month and its effect on progress and completion of the Work, and

(3) Promptly (but not more than fourteen days) after giving notice of the delay, the Contractor provides the Engineer with sufficient data and documentation to establish that the weather conditions experienced were unusually severe for the locality of the work during the month in question and that such unusually severe weather directly impacted the work such that completion of the entire work is unavoidably delayed. Unless otherwise provided in the Contract Documents, data documenting unusually severe weather conditions shall compare actual weather conditions to the average weather conditions for the month in question during the previous five years as recorded by the National Oceanic and Atmospheric Administration (NOAA) or similar record-keeping entities.

13.6 Adjustments, if any, of the time for completion pursuant to this Article shall be incorporated into the Contract by a Contract Change Order prepared by the Engineer and signed by the Contractor, Owner, and Engineer or, at closeout of the Contract, by mutual written agreement between the Contractor and Owner. The adjustment of the time for completion shall not exceed the extent to which the delay necessarily and unavoidably extends the time required to complete the entire work of the Contract.

13.7 The Owner shall not suffer any loss or expense as a result of such occurrences or delays and the Contractor shall not be allowed any damages or claims for extra compensation resulting from such occurrences or delays, except to any extent proved to have been actually caused solely by unjustified affirmative actions on the part of the Owner.

14. CONSTRUCTION SCHEDULE

14.1 The Contractor shall submit to the Engineer, prior to initiating the work but not later than thirty days after the execution of the Contract, a schedule of construction operations so planned as to ensure completion of the work within the time limit specified in the Contract Agreement. The maintenance of such schedule in order to fulfill the terms of the Contract Agreement is the responsibility of the Contractor, and he shall employ such reasonable and proper measures, subject to other conditions of these Contract Documents, as he deems to be required to expedite the work and to ensure that it will be fully and satisfactorily completed within the stated time limit. Submission and review of schedule by Engineer/Owner is for general compliance with Contract requirements. Contractor shall remain solely responsible for developing and updating the schedule, reviewing plans and discussing operations with Owner/Engineer, understanding and becoming familiar with the Owner's facilities/operations, understanding potential impacts on the Owner's facilities/operations, identifying sequence of work, potential conflicts, work restrictions, and phasing, all as required to meet the completion dates.

If the Contractor's progress falls materially behind the currently approved construction schedule and, in the opinion of the Engineer or Owner, the Contractor is not taking sufficient steps to regain schedule, the Engineer may, with the Owner's concurrence, issue the Contractor a Notice to Cure. In such a Notice to Cure the Engineer may require the Contractor to submit a revised construction schedule to demonstrate the manner in which schedule will be regained. The Contractor shall not be allowed additional compensation for employment of such measures.

14.2 The Contractor will be required to show in the schedule the proposed dates of commencement and completion of the various subdivisions of the work, and also to show in the schedule the estimated amount of each monthly payment (periodic estimate) that will become due to the Contractor as he maintains the progress schedule prepared by him. The preparation and submittal of the progress and payment schedule to the Owner is of benefit both to the Contractor and the Owner in that it will enable the Owner to anticipate the periodic financial needs of the project and facilitate the making of timely payments for the work. Submission of a schedule showing a completion date beyond the contract completion date should not be interpreted as approval of a contract extension by the Owner.

14.3 The Contractor shall prepare and keep current a schedule of submittals coordinated with the Contractor's schedule of construction operations. The submittal schedule is subject to approval by the Owner and shall allow the Owner/Engineer reasonable time the review submittals.

15. SUPERVISION OF THE WORK

15.1 The Contractor shall be solely responsible for planning, scheduling, organization and prosecution of the work in accordance with the Contract Documents. Observations, construction reviews, tests, recommendations or comments made by the Engineer, or by persons other than the Contractor, shall in no way relieve the Contractor of his/her obligation to timely complete all work in accordance with the Contract Documents. All work shall be done under the direct supervision of the Contractor. The Contractor shall be solely responsible for construction means, methods, techniques, sequences and procedures. The Contractor is solely responsible for safe access to the work, safe use of the work, safe working conditions, and safe occupancy of the work by and/or for all authorized persons.

15.2 The Contractor shall maintain on the project (full time) a qualified superintendent who is acceptable to the Engineer and the Owner, and who is capable of providing the efficient supervision required for the successful, timely, and satisfactory completion of the work. The superintendent shall have full authority to act in behalf of the Contractor, and all communication with the superintendent shall be considered a communication with the Contractor. The Contractor's superintendent is responsible for coordinating the work of all subcontractors, and his/her presence at the site of the work is necessary for the adequate performance of his/her supervisory duties and for the coordination of the work of all subcontractors.

15.3 The responsibilities of the Contractor relating to supervision of the work as outlined hereinabove, and the duties of the Contractor as outlined hereinabove, are all a part of the General Conditions of this Contract as referred to in the Contract Agreement.

16. SUBCONTRACTORS

16.1 The Contractor may utilize the services of specialty subcontractors on those parts of the work which, under normal contracting practices, are performed by subcontractors. No part of the work, however, shall be sublet by the Contractor without the prior written consent of the Owner. Following the execution of the Contract, the Contractor shall submit in writing for review by the Engineer and the Owner the names of subcontractors to whom he proposes to subcontract portions of the work. The Engineer shall promptly reply to the Contractor in writing stating whether or not the Owner or the Engineer has reasonable objection to any proposed subcontractor. If the Owner or the Engineer has reasonable objection to a listed subcontractor, then the Contractor shall propose another which is

acceptable to the Owner and the Engineer, without an increase in the Contract amount. The early selection of subcontractors, in the case where the Contractor proposes to subcontract any part of the work, is essential to the proper organization of the work, and the Contractor shall therefore submit any names of proposed subcontractors upon or before request by the Owner or Engineer.

16.2 The names of proposed subcontractors so submitted shall not be changed by the Contractor after submittal of the list to the Engineer and Owner unless the consent of the Owner is first obtained.

16.3 The Contractor shall be responsible to the Owner for the acts, deficiencies, and omissions of his/her subcontractors, suppliers, and vendors (of every tier), and those of their direct and indirect employees, to the same extent as he is responsible for the acts, deficiencies, and omissions of his/her own and those of his/her employees.

16.4 The Contractor shall bind all subcontractors to the terms of the General Conditions and other Contract Documents insofar as they are applicable to the work under subcontract, and shall insert in all agreements with subcontractors appropriate provisions such as to give the Contractor the same power as regards terminating any subcontract that the Owner may exercise over the Contractor under any provision of the Contract Documents. The Contractor is required to submit evidence of compliance with such conditions to the Owner before commencement of work by the particular subcontractors.

16.5 Nothing contained in the Contract Documents shall be construed as creating any contractual relationship between any subcontractor and the Owner.

16.6 For convenience of reference, to facilitate organization of the work, and for convenience in evaluating work in progress, the Specifications have been separated into titled Sections. Such separation shall not, however, operate to make the Owner or the Engineer an arbiter to establish limits of work in the contracts between the Contractor and subcontractors. The general charge to the Contractor is that all work be fully completed in accordance with the Contract Documents, and that the Contractor adhere to the terms and provisions of the Contract Agreement, of which these Conditions are a part.

17. CONTRACTOR'S RESPONSIBILITIES WITH RESPECT TO WORK BY OTHERS

17.1 The Owner reserves the right to perform construction or operations related to the project with his/her own forces, and to place portions of the work on the project under separate contracts. The Owner and the Contractor shall be mutually responsible for coordination of the activities of the Owner’s own forces or separate contractors with the work of the Contractor. The Contractor shall cooperate with other contractors with regard to use of the site, storage or materials, and execution of their work.

17.2 It is the Contractor's responsibility to inspect thoroughly all work performed by other contractors which may in any manner affect his/her work, and to notify the Engineer and the Owner in writing of the existence of any irregularities or discrepancies which will not permit him/her to complete his/her work in a satisfactory manner. Such written notice shall be provided within seven days after the Contractor first observes or suspects any irregularity or discrepancy. The failure of the Contractor to notify the Owner of the existence of such irregularities or discrepancies shall indicate that the work of other contractors has been satisfactorily completed and is in condition to receive his/her work.

17.3 The Contractor is required to keep himself/herself informed of the progress and performance of other contractors; and, where the lack of progress or poor performance

(defective workmanship) on the part of other contractors will affect the Contractor in the performance and completion of his/her work, he shall immediately notify the Engineer and Owner in writing of the existence of such conditions. Failure of the Contractor to keep himself/herself informed of the status and condition of work being performed by other contractors on the project, where the status or condition of such work may affect the performance of his/her work, and failure of the Contractor to notify the Owner of status or conditions unfavorable to the proper coordination, performance, and completion of his/her work shall be construed to be acceptance by the Contractor that the status and condition of work being performed by other contractors is satisfactory for the proper coordination, performance, and completion of his/her work.

18. SATURDAY, SUNDAY, HOLIDAY, NIGHT AND OVERTIME WORK

18.1 Work on Saturdays, Sundays and Holidays, or at night, will be permitted only when the Contractor has received the written permission of the Owner. Work at such times may be required when special connections to existing systems are to be made, when new facilities are to be placed in service, when existing facilities are to be taken out of service, when it is more advantageous to the utilities involved, or when an emergency arises in the work schedule. In such cases the permission of the Owner must be secured prior to beginning work at such times, the work scheduled well in advance, and arrangements made for prosecution of the work with all safety and minimum inconvenience to the Owner and the public. All work necessary to be performed on Saturdays, Sundays and Holidays, or at night shall be so performed without additional expense to the Owner.

Except as described above (e.g. as required for special connections, emergencies, and/or operational constraints), the time and expense associated with the Owner's on-site field representative, and other costs resulting from Saturday/Sunday/Holiday/Night work shall be deducted from the Contractor's monthly pay application(s).

18.2 Holidays for the purposes of this project shall be defined as those holidays normally observed by the Owner.

18.3 It is understood that the Contractor's proposed construction schedule is based on a 40 hour work week occurring within 10 hour days, Monday through Friday, less recognized holidays. The Contractor shall be responsible for additional expenses incurred by the Owner for the Engineer's field representative overtime premium associated with work hours in excess of the 40 hour work week. This cost will be deducted from the Contractor's monthly payment request, and will be $45 per hour. No overtime pay will be charged to the Contractor for work performed at night or on weekends, when, due to operational conditions of the Owner's facilities, the work must be performed during these non-standard work hours.

18.4 Maintenance work normally required for protection of persons, or for protection of the work or property, will be permitted at any time.

18.5 For work during an emergency threatening bodily injury, loss of life, or damage to property refer to Article 19 of these General Conditions.

19. EMERGENCY WORK

19.1 It is the Contractor's responsibility at all times to guard against bodily injury, loss of life, damage to the Owner's property, damage to his/her own work on the site, and damage to adjacent property. In the case of the development of an emergency which threatens loss of life, injury to persons, or damage to property, it is the Contractor's responsibility to furnish and install all necessary materials and equipment, and to perform all work as could

possibly be accomplished to prevent loss of life, bodily injury, or damage to property. In all such cases the Contractor shall immediately notify the Engineer and Owner of the emergency, but he need not wait for advice or authorization from the Engineer or the Owner before proceeding to employ all measures necessary to protect life and property. Nothing stated hereinabove shall be construed as limiting the Contractor's responsibility under the terms and provisions of the General Conditions and other Contract Documents to protect life and property and to pay claims resulting from loss of life, bodily injury, or damage to property. The substance of this Article of the General Conditions is that, in case of an emergency, the Contractor will act reasonably and responsibly with all speed, with all force, and in an expeditious manner, to avert loss of life, bodily injury, and property damage.

20. CHANGES IN WORK

20.1 The Owner shall have the right to make additions, deletions, or changes to the work, and to require the Contractor to perform Extra Work. These may be accomplished by Change Order, Construction Change Directive, or by written order for minor changes in the work, and shall be performed under applicable provisions of the Contract Documents. If the Contractor believes that any addition, deletion, change, or Extra Work entitles the Contractor to additional compensation or a time extension, then the Contractor shall so notify the Engineer and the Owner in writing within seven days after the addition, deletion, change, or Extra Work is first proposed, and then shall not proceed unless he thereafter receives a written directive to do so that is signed by the Engineer and the Owner. The Contractor shall not be entitled to any additional compensation or additional time unless he has fully complied with these requirements. Such increases, decreases, changes, and Extra Work shall not invalidate the Contract.

20.2 Where new items of work which could not have been anticipated are found to be necessary for the satisfactory completion of the project, and where the character of the work is such that a reasonable price for the performance of the work cannot be established by use of contract prices or combinations thereof, such new and unanticipatable items of work shall be classed as Extra Work. No Extra Work shall be undertaken except by written order in the form of a Change Order or Construction Change Directive signed by the Engineer and the Owner. The Contractor shall, upon receipt of written order from the Owner, perform such Extra Work and furnish such materials as may be required for the proper completion of construction of the whole work contemplated. In the absence of such written order no claim for extra compensation or a time extension by reason of performance of Extra Work shall be allowed. Extra Work shall be performed in accordance with the Contract Documents, insofar as they are applicable; and where such Extra Work is not covered by the Contract Documents, the performance of the work shall be consistent with the intent of these Contract Documents.

21. FAULTY WORK AND DEFECTIVE WORK

21.1 The performance of satisfactory work that complies with and conforms to all requirements and provisions of the Contract Documents is the obligation of the Contractor, and the Contractor hereby provides the Owner a warranty and guaranty against faulty and defective work. Any faulty work or defective work, whether the result of poor workmanship, use of defective materials, damage through carelessness or any other cause, will neither be accepted nor paid for and shall constitute a breach of the Contractor’s warranty and guaranty. The terms “faulty work” or “defective work” include, but are not limited to: (1) any product, material, system, process, equipment, or service, or its installation or performance, which does not conform strictly to the requirements of the Contract Documents, (2) in-progress or completed work the workmanship of which does not

conform to the quality specified and also to the quality produced by skilled workers performing work of a similar nature on similar projects in the state, (3) substitutions and deviations not properly submitted and approved or otherwise authorized by the Owner, (4) materials or equipment rendered unsuitable for incorporation into the work due to improper storage or protection or other causes; and (5) any work that does not fulfill its intended function and purpose. The Contractor and its performance bond surety shall bear and be responsible for all losses, damages, costs, and expenses related to faulty or defective work, including but not limited to: (a) correction, remediation, or replacement of the faulty or defective work; (b) additional testing and inspections, including repeating specified inspections and tests, (c) reasonable services and expenses of the Engineer, and (d) the expense of making good all work done by the Contractor, Owner, or separate contractors which is destroyed, damaged, or altered by the correction of the faulty or defective work. Payment for faulty or defective work will not be made until such work has been removed, re-executed, and corrected in a manner and form satisfactory to the Engineer and the Owner and in accordance with the Contract Documents. The existence of any known faulty or defective work will prevent the acceptance of the work. The fact that the Engineer may have previously inspected and failed to reject such faulty or defective work shall not constitute acceptance of any part of it. Neither the failure by the Engineer to discover faulty or defective work prior to the making of final payment by the Owner to the Contractor, nor the discovery or appearance of faulty or defective work after the making of said final payment, shall relieve the Contractor (or his/her performance bond surety) of responsibility for faulty or defective work.

21.2 If the Contractor fails to correct faulty or defective work within a reasonable time to the satisfaction of the Engineer, then the Owner may, at the Owner's sole discretion, and upon written notice to the Contractor, have the faulty or defective work corrected by others and recover all losses, damages, costs, and expenses associated with the correction of the faulty or defective from the Contractor and its performance bond surety.

22. UNCOVERING WORK

22.1 If any portion of the work is covered by the Contractor or his/her subcontractors contrary to the requirements expressed in the Contract Documents or the Engineer's specific request, it shall be uncovered for the Engineer's observation and recovered at the Contractor's expense without change in the Contract Amount or time for completion.

22.2 The Engineer may request to see covered work which has not been specifically requested by the Contract Documents or the Engineer to remain uncovered until observed by the Engineer. If such work has been properly installed according to the Contract Documents, then the actual direct costs for uncovering and replacement shall be charged to the Owner. However, if such work is in whole or in part not in accordance with the Contract Documents, then the Contractor shall bear all costs for uncovering and replacement.

23. USE OF COMPLETED PORTIONS OF THE WORK

23.1 The Owner shall have the right to take possession of and use any completed or partially completed portion of the work, provided all insurers and authorized public authorities having jurisdiction over the project consent to this partial possession and use, notwithstanding that the time for completing the entire work or such portions of the work may not have expired; but such taking possession and use shall not be deemed to be acceptance of any work not completed in accordance with the Contract Documents. The Owner and the Contractor shall agree in writing on the equitable assignment of security, maintenance, utilities, commencement of warranties, insurance and damages to the areas of work to be used by the Owner. If the Contractor believes that any such prior use will

increase the cost of, or delay the completion of, uncompleted work, or cause re-finishing of completed work subjected to such prior use, then the Contractor shall so notify the Engineer and the Owner in writing promptly and before the prior use begins. The Contractor shall not be entitled to extra compensation or an extension of time on account of any such prior use unless the Contractor has complied with this requirement, and the Contractor and the Owner have mutually agreed upon such additional compensation or extension of time.

23.2 Prior to occupancy or use by the Owner of any partially completed work, the Owner, the Contractor and the Engineer shall inspect the portion of work to be occupied and used by the Owner to record the condition of the work.

24. CUTTING AND PATCHING OF WORK

24.1 The Contractor shall perform all necessary cutting and patching as required to connect new work to existing work and as required in new work to properly receive the work of the various trades involved in the entire work; and the Contractor shall restore all such cut and patched work, and shall refinish all surfaces affected by such work, to conditions acceptable to the Engineer. Cutting of the existing work, or any work, in such a manner as would endanger the work, adjacent property, the workmen, or the public, is contrary to the provisions of Article 8, SAFETY.

25. CLEANING UP THE WORK

25.1 During performance of the work, the Contractor shall keep the property and the surrounding areas free from the accumulation of waste materials or rubbish caused by the Contractor's operations. If the Contractor fails to keep the site clean, the Owner may do so at the expense of the Contractor.

25.2 At completion of the work the Contractor shall remove from the property of the Owner, and from all public and private property, all temporary structures, rubbish, and waste materials, and surplus materials resulting from his/her operations or caused to be in such locations by actions of his/her employees, subcontractors, suppliers, or vendors. The Contractor shall remove all of his/her equipment, tools, and supplies from the property of the Owner. The entire work shall be clean and finished as specified. The site shall be clean, true to finished contours given, and improved as specified. The entire work shall be ready for permanent occupancy and/or use before acceptance of the work can become fact. Should the Contractor fail to remove his/her equipment, tools and supplies from the property of the Owner, the Owner shall have the right to remove them at the expense of the Contractor.

26. CONTRACTOR'S RESPONSIBILITY FOR PERFORMANCE AND ACTIONS OF WORKMEN

26.1 The Contractor is responsible for the conduct, performance, acts, and omissions of all persons and entities on the project site who are engaged in work on behalf of the Contractor under this Contract. All workmen should have such skill, training, and experience as will enable them to reliably, safely and properly perform the particular work or task assigned to them. It is in the best interest of the Contractor to terminate the employment of workmen whose performance endangers the safety of other workmen or any person, or results in unsatisfactory work, or contributes to delay in the progress of the work, before the Contractor bears the burden of re-executing unsatisfactory work and suffers the cost of delays in the prosecution of the work.

26.2 The Contractor may be requested by the Owner to remove or to have removed from the job site for the duration of the project any of his/her employees, or any of his/her subcontractors, or any of the employees of his/her subcontractors, who acts in a disorderly or intemperate manner, or who is abusive to representatives of the Owner or of the Engineer or of any Agency having jurisdiction over the project, or who acts in such a manner as would endanger the safety of any person or of the work, all of which acts could give cause for concern for the safety of any person or of the work, for which safety the Contractor is solely responsible.

27. GUARANTY

27.1 The Contractor warrants and guarantees to the Owner that all of the Contractor's work will strictly comply with the Contract Documents, will be free from faulty work and defective work, and will perform as intended. The Contractor and his/her performance bond surety shall be obligated and liable for the correction of any work that does not comply with this warranty and guaranty, together with the cost of repairing or replacing any other work, equipment, facilities or property damaged in connection with the correction of work that does not comply with this warranty and guaranty, and all losses, damages, and expenses incurred by the Owner as a result of any failure of the Contractor's work to comply with this warranty and guaranty.

27.2 Without limiting any other obligation of the Contractor, including, but not limited to, those provided in Article 21 and those provided in Section 27.1 above, and with without limiting any other right or remedy of the Owner, the Contractor agrees that as a separate and independent affirmative obligation, the Contractor shall return to the project and correct any faulty work, defective work, or work that otherwise does not comply with the Contractor's warranty or guaranty, that is identified within one year after the date that the Final Payment Application is signed by the Owner. This separate and independent obligation shall not be construed as a time limit for enforcement by the Owner of any of the Contractor's warranties, guaranties, or other obligations under the Contract Documents.

27.3 No progress payment or final payment, or certificate of payment, or any provision of the Contract Documents, or partial or entire occupancy or use of the work by the Owner, shall constitute an acceptance of work not done in accordance with the Contract Documents or relieve the Contractor of any responsibility or liability in respect to any warranties, guaranties, or other obligations or responsibilities for faulty work or defective work.

27.4 The Contractor's performance bond surety is bound and liable to the Owner to the same extent as the Contractor for performance of the foregoing warranty and guaranty obligations (and the obligations provided in Article 21), and for any damages arising from any breach of or failure to comply with any such obligations. The Contractor's surety shall remain bound and liable for such obligations and damages notwithstanding the completion or acceptance of the work, final payment, or any otherwise applicable time restrictions or other limitations (including the time for filing suit) recited in the surety's bond.

28. MATERIALS AND EQUIPMENT

28.1 The materials and equipment incorporated or installed in the work shall be new and of good quality, free from defects and irregularities, and shall meet all requirements of the Contract Documents, including, but not limited to, those in Articles 21 and 27 above. All materials and equipment shall be subject to review by the Engineer, and no materials and equipment shall be ordered until information relating to such materials and equipment has been reviewed by the Engineer. The Contractor shall be responsible for furnishing and

installing all materials and equipment required for the complete work, and all materials and equipment so furnished and installed shall be warranted and guaranteed by the Contractor in accordance with the provisions of Articles 21 and 27 above.

28.2 It is essential that all material, manufactured articles, and equipment be applied, installed, erected, connected, cleaned, conditioned for use and placed in service in accordance with the instructions of the particular manufacturer of such materials, articles, and equipment.

28.3 Only those manufactured and fabricated items fully complying with applicable standards of the Occupational Safety and Health Administration may be offered, and the manufacturer's or fabricator's certificate to that effect will be required with the submittal of each item by the Contractor.

28.4 Items of equipment, articles or materials which are not equal to samples reviewed by the Engineer, do not conform to the requirements of the Drawings or Specifications or the requirements of applicable standards, or are in any way unsatisfactory or unsuitable for the purpose or service for which they are intended, shall neither be furnished nor installed.

28.5 In order to establish standards of quality, the detailed Specifications, or the Drawings, may include references to certain products by name or by name and catalog number. This procedure is not to be construed as eliminating from competition other products of equivalent or better quality as manufactured by other companies, unless specifically stated that no other manufacturers will be acceptable. Materials or articles which, according to the judgment of the Engineer, will fully meet the design criteria, are equivalent in function and durability, and are suitable for use in arrangement as shown on the Drawings, may be acceptable.

28.6 It must be understood that equipment and articles of different manufacturers, although they may be equivalent in construction, quality, durability and performance, may not have the same dimensions, configurations and arrangement of connections. It then becomes the responsibility of the Contractor to take into consideration any variations in dimensions and connection arrangement of the equipment or articles that he proposes to offer from those of equipment shown on the Drawings, or called for in the Specifications, and make certain that the proposed equipment or article can be installed in a neat and efficient arrangement in the space available. In the layout of the equipment and connections thereto, accessibility for proper maintenance is a requirement in order to ensure satisfactory operation.

28.7 Substitution of equipment, articles or materials other than those shown on the Drawings or specifically named in the Specifications, when requested by the Contractor, will be considered, provided that the design and construction of such equipment, articles, or materials establish that they will meet the requirements of the Specifications and Drawings. By tender of a request for a substitution, the Contractor represents that he has fully investigated and analyzed the product, and that he guarantees that the product will fully meet the design criteria of the product specified, has the durability and life expectancy of the product specified, is equivalent in function and performance to the product specified, and is suitable for installation in efficient arrangement in the space shown on the Drawings. The Engineer will review the proposed substitutions and make his/her recommendations within a timely manner as defined below. The Contractor shall abide by the Engineer's decision when proposed substitute equipment, articles or materials are not recommended for installation and, in such case, shall furnish the specified article, item of equipment or material. The decision of the Engineer to accept the substitute product shall not relieve the Contractor of his/her warranty, guaranty, and other obligations provided in the Contract Documents with respect to the Contractor’s work.

28.8 In order to be considered by the Engineer, any request by the Contractor for substitution of products must be made in a timely manner. By "timely" it is meant that any such requests should be made as early after the commencement of the work as is possible so that sufficient time will be allowed for: review by the Engineer along with review of other submittals in connection with the project; in case of rejection of the submittal, preparation of succeeding submittals covering other substitute products; reviews of the succeeding submittals; ordering and manufacture of an acceptable product; delivery of product to job site well in advance of the time that it is scheduled to be installed.

29. SHOP DRAWINGS AND PRODUCT DATA

29.1 Shop drawings are drawings, diagrams, and other data prepared for the work by the Contractor, subcontractor, or supplier to illustrate some portion of the work. Product data are illustrations, schedules, charts, brochures, instructions or other information furnished by the Contractor, subcontractor, or supplier to illustrate materials or equipment for some portion of the work. Shop drawings and product data are submitted to demonstrate how the Contractor proposes to conform to the requirements of the Contract Documents.

29.2 The Contractor shall provide all shop drawings and product data as may be necessary for the proper and satisfactory prosecution of the work, all in accordance with the intent of the Contract Documents to secure a complete and operable project capable of satisfactory performance of the service intended. The shop drawings and product data shall be submitted in accordance with an orderly schedule based upon time required for review, approval, ordering, and fabrication or manufacture, and delivery, and upon the time at which materials, fabricated items, or manufactured items will be required to be incorporated in the work. The Contractor shall perform no portion of the work requiring submittal and review of shop drawings and product data prior to receipt of the Engineer's approval. Ordering material or equipment by the Contractor prior to receipt of concurrence from the Engineer will be fully at the Contractor's risk, even if the materials or equipment ordered are identical to the items listed in the Specifications or shown or the Drawings. No consideration will be made for reimbursement to the Contractor for restocking fees, purchase costs, delivery costs, or any other expenses caused by the Contractor's decision to place premature orders for materials or equipment.

29.3 The Engineer’s review of shop drawings is not intended to verify the accuracy and completeness of details such as dimensions and quantities or to substantiate installation instructions or performance of equipment or systems, all of which remain the responsibility of the Contractor. Deviations from the Contract Documents shall be specifically and conspicuously called to the attention of the Engineer by the Contractor at the time when such shop drawings or product data are first submitted to the Engineer for his/her consideration. The Engineer's review of any drawings shall not release the Contractor from responsibility for such deviations, or any subsequent deviations not noted by the Contractor or the Engineer.

29.4 During the bid period and again prior to submitting/ordering and installing materials, products and equipment, the Contractor and all manufacturers and suppliers shall thoroughly review the materials, products and equipment being supplied and shall familiarize themselves with the existing and proposed/new facilities, as well as connections to existing facilities/utilities. This shall include field verification of the location, nature, size/dimensions, current and intended future use, etc. Prior to ordering and installation, the Contractor shall coordinate with all manufacturers and suppliers to provide all needed information including field dimensions, photographs, information on related

materials and equipment, etc.). The Contractor and all manufacturers and suppliers shall confirm the following:

1. The materials, products, and equipment being supplied are of the correct size, materials and type
2. The materials, products and equipment being supplied do not conflict with existing or proposed/new facilities.
3. The products/equipment being supplied are intended for use in this application.

All manufacturer(s) and supplier(s) shall provide (either with submittals or separately) written concurrence/acknowledgement of their review/coordination and concurrence with the items above.

Shop drawings and product data submitted for review by the Engineer shall bear the Contractor's certification that he has reviewed, checked, and approved the submittals, that they comply with the requirements of the project and with the provisions of the Contract Documents, and that he has verified all sizes, dimensions, locations, field measurements, construction criteria, materials, catalog numbers, and similar data. Field dimensions, sizes and other pertinent information shall be clearly shown on the shop drawings/submittals. The Contractor shall also certify that the work represented by the shop drawings is recommended by the Contractor and that the Contractor's warranty and guaranty will fully apply.

29.5 All shop drawings and product data submitted to the Engineer shall be numbered by the Contractor using a three part numbering methodology. The three part number shall include a submittal number, the specification section number where the submitted item is described, and an indication of whether the information is an initial submittal or a resubmittal.

30. PROJECT RECORD DOCUMENTS

30.1 The Contractor shall maintain at the site one record copy of the Contract Documents, approved Shop Drawings, Product Data, Samples and other required submittals. These are to be in good order and marked to record changes made during construction. When required in other Division 1 sections (Project Record Documents and/or Project Closeout Procedures), the Contractor shall, upon Substantial Completion and prior to Final Completion, engage a licensed surveyor to perform a topographic and planimetric survey as required to document/record the “as-built” location of the Work. The survey shall be provided in digital (CAD/dwg or dgn) format. All site documents shall be delivered to the Engineer for submittal to the Owner at the completion of the work.

31. TEST REPORTS AND CERTIFICATES

31.1 Certified statements of compliance, where required by the Specifications, shall be furnished by the Contractor.

31.2 Certified mill test reports, where required by the Specifications, shall be furnished by the Contractor.

32. STORAGE OF MATERIALS AND/OR EQUIPMENT

32.1 Materials or equipment to be incorporated in the work shall be properly housed or otherwise protected from corrosion and damage so as to ensure the preservation of their finish, quality, and fitness for the work, all in accordance with the manufacturer’s

recommendations. Where considered necessary to secure proper protection, the materials shall be placed on racks, platforms, or hard clean surfaces not subject to surface drainage or excessive moisture. Factory finished items shall be stored above ground, covered, individually sealed, or housed indoors as required. Materials not properly stored, housed and maintained in condition for service as intended will neither be paid for as stored materials nor as materials incorporated in the work.

32.2 Stored materials and equipment shall be located and arranged so as to facilitate observation. Private property shall not be used for storage purposes without the written consent of the owner or lessee of said property. When the Contractor desires to accept delivery of material or equipment which cannot be accommodated or housed on the site of the work he may, but only with the permission of the Engineer and the Owner, store such material and/or equipment in an adequately insured warehouse. Any agreement for rental of such storage space by the Contractor shall contain a provision that the material and/or equipment thus stored shall not be subject to a lien for payment of storage. The Owner shall be protected against loss of or damage to such stored equipment by the terms and endorsements of the Contractor's insurance policies.

33. LANDS AND RIGHTS-OF-WAY

33.1 The Owner will provide the lands (property, easements and /or rights-of-way) shown on the Drawings, or described in the Specifications, upon which the work under the Contract is to be performed, and which are to be used for access to the work. Any delay in furnishing these lands by the Owner that would prevent the Contractor from beginning the work or continuing the prosecution of the work, may be deemed to be proper cause for adjustment of the time for completion of the work or for adjustment of the Contract Amount.

33.2 Any land and access thereto not specifically shown to be furnished by the Owner that may be required for temporary construction facilities or for storage of materials shall be provided by the Contractor with no cost or liability to the Owner. The Contractor shall confine his/her equipment, apparatus, and storage to such additional areas as he may provide at his/her own expense.

33.3 The Contractor shall not enter upon private property for any purpose without obtaining permission; and the Contractor shall be responsible for the preservation of all public property, trees, monuments, structures and improvements, along and adjacent to the street and/or right-of-way, and shall use every precaution necessary to prevent damage or injury thereto. The Contractor shall use suitable precautions to prevent damage to pipes, conduits, other underground structures, and utilities. The Contractor shall carefully protect from disturbance or damage all monuments and property marks until an authorized agent has witnessed or otherwise referenced their location; shall not remove such monuments and property marks until authorized to do so; and, in the event that they should be removed, shall replace them in original location when the work in the area has been completed.

34. ACCESS TO THE WORK

34.1 The Engineer and his/her representatives shall have free access to the work at all times and shall be given full opportunity to observe the work in progress and to examine such records of the Contractor as may have bearing on the proper review and observation of the work. The Contractor shall provide at the site of the work such space as would be reasonably adequate to serve as a field office for representatives of the Engineer and as storage area for their equipment and supplies.

35. OBSERVATION OF THE WORK

35.1 The Engineer will decide questions which may arise as to the quality and acceptability of materials and/or equipment furnished, the quality and acceptability of work performed, interpretations of the Contract Documents, and all questions with respect to the acceptable fulfillment of the Contract on the part of the Contractor. The Contractor shall abide by these decisions. The duties and responsibilities of the Engineer as set forth herein shall not be extended except through signed written consent of the Engineer and the Owner.

35.2 All materials and each part or detail of the work shall be subject at all times to observation by the Engineer and the Owner, and the Contractor shall be held strictly to the intent of the Contract Documents in regard to quality of materials, equipment and workmanship, and also in regard to the diligent execution of the Contract. Observations may be made at the site, or at the sources of supply, of material whether mill, plant or shop. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make his/her observations and construction review.

35.3 The Engineer's decision as to the acceptability or adequacy of the work shall be final and binding upon the Contractor. The Contractor agrees to abide by the Engineer's decision relative to the performance of the work.

35.4 All claims made by the Contractor shall be submitted to the Engineer for his/her decisions. Such decisions shall be final except that, in cases where time and/or financial considerations are involved, the claims shall also be submitted to the Owner for his/her review and shall be subject to the approval of the Owner. Meritorious claims shall be resolved, if possible, by mutual agreement between the Contractor and the Owner. Regardless of whether the Engineer or the Owner has actual or constructive notice of any claim of the Contractor for additional compensation, time, or other consideration, the Contractor agrees that such claim is waived and forfeited unless it is set forth in detail in a written notice to the Engineer, and delivered to the Engineer as soon as practicable in the circumstances, but in any event no later than ten days after the first occurrence of any of the conditions out of which such claim arises.

35.5 During the construction of the work, as defined by the Drawings and Specifications therefor, the Owner/Engineer may assign a Field Representative to the project. The duties of the Field Representative shall consist of visual review of materials, equipment and construction work for the purpose of ascertaining that the product of the Contractor's work conforms to the Drawings and is conformance with the intent of the Specifications for the project. The presence of the Field Representative at the site of the work shall not be relied upon by others as acceptance of the work, nor shall it be so construed as to relieve the Contractor in any way from his/her obligations and responsibilities under the Contract Documents. Review of the construction work by the Field Representative or by the Engineer shall not require either the Engineer or the Field Representative to assume responsibilities for the means and methods of construction nor for safety on the project site, in areas adjacent to the project site, or in other areas affected by the work performed on the project.

36. SCHEDULE OF VALUES & UNIT PRICES

36.1 The Contractor shall, within ten days of receipt of Notice to Proceed, submit a Schedule of Values showing the value assigned to each part of the work, the total of the assigned values of all parts or components being equal to the total Contract Price. The Schedule of Values shall be consistent with the line item amounts in the Contractor's Proposal form. Such breakdown, or division of the work into parts or components according to trades or sections of the Specifications, shall have the concurrence of the Engineer before being used as the basis for estimating partial payments for work performed under the Contract. No partial payment will be made to the Contractor until an acceptable Schedule of Values is approved by the Owner. The costs shown in the Schedule of Values shall not, however, be considered as fixing a basis for additions to or deductions from the Contract Price, nor shall they be considered as fixing a basis for computing the cost of Extra Work.

36.2 The Schedule of Values shall correlate with the construction categories which make up the Application for Payment and shall be updated and resubmitted when a Change Order or Construction Change Directive is issued which results in a change to the Contract Amount.

36.3 Where unit prices form the basis for payment under the Contract, such unit prices as set forth in the Proposal, when applied to the corresponding quantities of work performed during a given estimate period, shall represent the value of work performed during that estimate period. It shall be understood, however, that the estimated quantities of work shown in the Proposal to be paid for on unit price basis are given for the purposes of determining the approximate value of the work and comparing bids, that the Owner reserves the right to increase or decrease the estimated quantities of work as may be deemed reasonably necessary or desirable by the Owner to complete the work contemplated under this Contract, and that such increase or decrease in the estimated quantities of work shall in no way, either vitiate this Contract or give cause for claims or liability for damages.

37. APPLICATIONS FOR PAYMENT

37.1 No later than the fifth (5th) calendar day of each month (or the next business day if such date falls on a weekend or legal holiday), and not more often than once a month, the Contractor shall submit to the Engineer for review an Application for Payment filled out and signed by Contractor covering the work completed as of the date of the end of the preceding month, accompanied by such supporting documentation as is required by the Contract Documents or otherwise reasonably requested by the Engineer. 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 the Owner has received the materials and equipment free and clear of all liens, and evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to the Engineer and the Owner. The Contractor shall submit three (3) executed copies of each Application for Payment to the Engineer. The Contractor shall complete every entry on the form, including notarization and execution by the person authorized to sign legal documents on behalf of the Contractor. Amounts of Change Orders and Construction Change Directives approved prior to the last day of the construction period covered by the Application shall be included. Entries shall match the data on the Schedule of Values and the construction schedule, and shall include waivers of mechanics liens and similar attachments when required by the Owner.

37.2 The Engineer's review and recommendation of the Contractor's Application for Payment shall be subject to the following:

A. That the Contractor or his/her superintendent on the work shall have agreed with the representative of the Engineer regarding value of work performed during the period covered by the Application for Payment before the Application for Payment is submitted to the Engineer.

B. That the payment application contains a line item for each of the following deductions:

1. Costs incurred by the Owner/Engineer due to Saturday/Sunday/Holiday/Overtime Work.
2. Other miscellaneous costs incurred by the Owner/Engineer (due to re-inspection, rework, evaluation due to insufficient documentation of claims for weather delays, etc.).
3. Liquidated Damages for missing the Substantial Completion Date
4. Liquidated Damages for missing the Final Completion Date

The Contractor shall obtain these costs from the Owner/Engineer each month and incorporate them into the estimate (pay application) before submitting the estimate to the Engineer for review.

C. That payment may not be made for work on which satisfactory test reports have not been received before the submittal of the Application for Payment.

D. That payment shall not be made for defective work or for faulty work not completely corrected before the submittal of the Application for Payment.

E. That retainage of 5% shall be withheld until the Contract has been completed and the work has been accepted, subject, however, to other provisions of these General Conditions.

F. That, following a certification by the Engineer that the work has been substantially completed in accordance with the provisions of the Contract Documents but has not yet been fully completed and accepted, the retainage may be reduced to such an amount as would reasonably cover 150% the cost of correction and completion of minor items of work found to be faulty or incomplete and the cost of the work remaining to be done in order to effect the completion of all of the work in full accordance with the provisions of the Contract Documents. The consent of the Surety shall be obtained prior to any reduction in retainage.

G. That in addition to retainage, the amount otherwise due on any Application for Payment may be reduced by amounts reasonably necessary to protect the Owner from any loss, cost, or expense that might arise from: (1) any faulty work, defective work, or work that does not comply with the Contractor's warranty and guaranty; (2) existing or anticipated claims against the Owner arising from the work; (3) reasonable evidence that the work cannot be completed for the unpaid balance of the Contract Amount; (4) reasonable evidence that the work cannot be completed within the time allowed by the Contract; or (5) any failure by the Contractor to strictly comply with any requirement or obligation provided in the Contract Documents.

37.3 Ten days after submission of the Application for Payment to the Owner with Engineer's certification and recommendation, the amount recommended and certified by the Engineer will become due and when due will be paid by the Owner to the Contractor.

37.4 The value of preparatory work done and the value of materials and/or equipment stored in accordance with the Contract Documents may be taken into consideration in the preparation of estimates, provided that materials stored meet the requirements of the Contract Documents.

37.5 The Contractor shall timely pay all bills, invoices, and charges for all labor, services, work, equipment, and materials acquired or used by the Contractor for the work. The Contractor agrees that he will indemnify and save the Owner harmless from all claims arising out of the lawful demands of subcontractors, laborers, workmen, mechanics, and suppliers of machinery, parts, equipment, power tools, fuel, materials and other construction items, incurred in the performance of work under this Contract. The Contractor shall, at the Owner's request, furnish satisfactory evidence that all obligations of the nature hereinabove described have been paid, discharged, or waived. If the Contractor should fail to do so, then the Owner may, after having served written notice on the Contractor, either directly pay those unpaid bills of which the Owner has received written notice, or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is presented that all such liabilities have been fully discharged, whereupon payment to the Contractor shall be resumed in accordance with the terms of this Contract, but, in no event, shall the provisions of this sentence be construed to impress upon the Owner any obligations to the Contractor, his/her surety, or to any of the Contractor's subcontractors, laborers, workmen, mechanics, or suppliers of any tier. In paying any unpaid bills of the Contractor, the Owner shall be deemed to be the temporary agent of the Contractor for this specified purpose; and any payment so made by the Owner shall be considered as a payment made under the Contract by the Owner to the Contractor, and the Owner shall not be liable to the Contractor for any such payments made in good faith.

38. PAYMENT FOR MATERIALS STORED

38.1 Payment for materials and equipment stored shall be subject to the requirements of these General Conditions.

38.2 No materials or supplies for the work shall be purchased by the Contractor or by any subcontractor subject to any chattel mortgage or security agreement, or under a conditional sale contract or other agreement by which an interest is retained by the seller. The Contractor warrants that he has good title to all materials, equipment, and supplies used by him/her in the work, and that such title is free from all liens, claims or encumbrances.

38.3 Payment for materials stored may be conditioned upon evidence submitted to establish the Contractor's title to materials and/or equipment stored, such as paid invoices, receipts of payment, satisfied purchase agreements, etc. When value of materials stored is allowed to be included in the Contractor's periodic estimates, the materials and/or equipment represented by such value shall become the property of the Owner, and the Contractor shall be responsible for safeguarding and using such materials and/or equipment in accordance with the provisions of the Contract Documents and shall retain all risk of loss or damage.

39. PAYMENT FOR EXTRA WORK

39.1 Extra Work shall be undertaken and prosecuted in accordance with the provisions of Article 20 of these General Conditions.

39.2 Payment for Extra Work may be made by use of one of the following methods:

A. Unit prices or combinations of unit prices which formed the basis of the original Contract.

B. A lump sum based upon the Contractor's estimate and accepted in writing (and signed) by the Owner.

C. Work Performed by the Contractor: Actual direct costs incurred solely, reasonably, and necessarily to perform the work plus fifteen percent (15%) of such actual direct cost to cover supervision, overhead, bond, other indirect costs, and profit. The Contractor shall submit to the Engineer and the Owner itemized cost sheets and documentation establishing the actual direct costs of performance of the Extra Work. Actual direct costs are defined as follows:

1. Actual documented labor costs, excluding supervisory personnel except for any time such personnel are at the project solely to supervise performance of the Extra Work and not for any other purpose.

2. Actual Labor-based Insurance and Workmen's Compensation Benefits costs attributable solely to labor actually and necessarily engaged in the performance of the Extra Work.

3. Social Security and unemployment contributions required by law for labor actually and necessarily engaged in the performance of the Extra Work.

4. Rental costs and charges for construction plant and/or equipment while actually and necessarily used in the performance of the Extra Work. Such costs or charges shall not exceed the lesser of AED Green Book standard rental rates, rental rates prevailing in the area of the work, or the Contractor’s internal job cost charges for such equipment. For equipment that is also on the project for work other than the Extra Work, only the documented time that such equipment is actually and necessarily engaged in performance of the Extra Work may be included, and no stand-by or idle time may be included. Daily rates shall be determined by dividing monthly rates by twenty-two (22); and hourly rates shall be determined by dividing monthly rates by one hundred and seventy-six (176). Rental rates or use rates shall not be charged for equipment having a value of less than $100.00 since equipment and tools having values of less than $100.00 are classed as small tools and as such are considered to be part of overhead.

5. Actual documented costs of materials and/or equipment entering permanently into the work.

6. Actual documented costs of power and consumable supplies for the operation of power equipment where such costs are not included in rental rates or use charges, and only for the incremental portions of such charges that are shown to have resulted solely from uses that were actually and necessarily required for performance of the Extra Work.

D. Work Performed by a Subcontractor for the Contractor: The Contractor shall eligible to receive five (5%) percent of its subcontractors' direct costs that are incurred solely, necessarily, reasonably to perform the Extra Work to cover all of the Contractor's costs of insurance, supervision, management, and other indirect costs. The subcontractor shall be entitled to its documented actual direct costs incurred solely, reasonably, and necessarily to perform the Extra Work plus fifteen percent (15%) of such actual direct costs to cover supervision, overhead, bond, other indirect costs, and profit. The Contractor shall submit to the Engineer and Owner itemized cost documentation showing the subcontractor's actual direct costs of performance of the work. Actual costs are defined above in C.1. through C.6 above.

40. SUBSTANTIAL COMPLETION

40.1 Substantial Completion is the point at which all (or a portion designated by the Engineer and the Owner) of the work has been sufficiently completed in accordance with the Contract Documents so the Owner can occupy and use the work for its intended purpose without any limitations or restrictions. Generally, and unless specifically stated otherwise in the Contract Documents, Substantial Completion must include all significant Work items such as demolition, site work, piping/utilities, equipment, concrete, masonry, buildings, miscellaneous metals, instrumentation and controls, fencing/gates, lighting/electrical, and access roads. Unless otherwise specifically stated in the Contract Documents, Substantial Completion does not include minor items such as signage, grassing, minor repairs and/or adjustments that do not affect performance/operation or use of the facilities, and other punch-list items.

On occasion, the Owner will designate a portion of the Work to be substantially complete so it can be occupied/placed into service, but this does not relieve the Contractor of responsibility achieve Substantial Completion and Final Completion on the remainder of the Work in accordance with the Contract Documents.

40.2 When the Contractor considers the work to be substantially complete, then the Engineer will observe the Work to determine whether or not the Owner will accept the work as being substantially complete. Repeat inspections, if required, will be performed by the Engineer at the Contractor's expense. The Engineer will notify the Owner when in the judgement of the Engineer the Work has reached substantial completion. The Owner may then elect to accept the Work as substantially complete, and the Engineer will issue a written Certificate of Substantial Completion.

40.3 Final Completion: After written Substantial Completion has been achieved, the Contractor will develop a list ("punch list") (for review by the Engineer) of remaining work items that must be completed in order to achieve Final Completion. The "punch list" is a working document, so items may continue to be added as they are identified. The Owner/Engineer will review the list and may add items to the list. Repeat "punch list" inspections, if required, will be performed by the Engineer at the Contractor's expense. Once the Contractor has completed all of the Work items (including punch list items) in accordance with the Contract Documents, the Engineer will notify the Owner when in the judgement of the Engineer the Work has reached Final Completion. The Owner may then elect to accept the Work as complete, and the Engineer will issue a written Certificate of Final Completion.

Additional requirements relating to Substantial Completion are contained in other sections of these General Conditions and in Division 1 sections of the Specifications.

40.4 Failure of the Contractor or the Engineer to include an item on the list of items to be completed for final acceptance does not alter the Contractor's responsibility to complete all work in accordance with the Contract Documents, or limit the Contractor's warranty or guaranty.

41. ACCEPTANCE AND FINAL PAYMENT

41.1 When the Contractor shall have completed all of the work in accordance with the terms of the Contract Documents, he shall so certify to the Engineer and the Owner that he has completed all of the work in accordance with the provisions of the Contract Documents. The Contractor shall also prepare and submit to the Owner a Final Request for Payment in an amount which shall be the Contract Amount plus all approved additions, less all approved deductions and less previous payments made.

41.2 The Contractor shall give notice of the completion of the work by advertisement in a newspaper of general circulation in the area in which the work has been performed and said notice shall appear once each week for a period of four (4) consecutive weeks. Proof of publication of said notice shall be furnished by the Contractor to the Owner by affidavit of the publisher of the newspaper, to which affidavit shall be attached a copy of the Notice.

41.3 When the Owner and the Engineer have completed a review of the work and of the request for final payment, and have determined that all of the work appears to completed in accordance with the provisions of the Contract Documents, final payment of the amount determined to be due under the Contract will be made to the Contractor, provided that:

A. Any deficiencies in the work, including outstanding warranty work, noted during the review shall have been satisfactorily corrected.

B. Final acceptance has been achieved.

C. The Contractor shall have submitted satisfactory evidence that all payrolls, all amounts due for labor and materials, and all other indebtedness connected with the work shall have been fully paid and satisfied; that there are no outstanding claims or demands against the Contractor in any manner connected with the work; submitted written consent of the Contractor's surety to final payment; and performed all other requirements relating to final acceptance as contained in other sections of these General Conditions and in Division 1 sections of the Specifications.

D. The Contractor shall have submitted an Affidavit of Release of Liens, and Affidavit of Payment of Debts and Claims, both as outlined below; and satisfactory evidence that there are not outstanding claims or demands against the Contractor in any manner connected with the work.

1. The Affidavit of Release of Liens shall include the following wording:
"The undersigned hereby certifies to the best of his/her knowledge, information, and belief, the Releases of Waivers of Lien attached hereto include the Contractor, all Subcontractors, all suppliers of materials and equipment, and all performers of work, labor, or services who have or may have liens against any property of the Owner arising in any manner out of the performance of the referenced Contract."

2. The Affidavit of Payment of Debts and Claims shall include the following wording:
"The undersigned hereby certifies that he has paid in full or has otherwise satisfied all obligations for all materials and equipment furnished, for all work, labor, and service performed, and for all known indebtedness and claims against the Contractor for damages arising in any manner in connection with the performance of the Contract referenced for which the Owner or his/her property might in any way be held responsible."

41.4 Final acceptance of the work shall be achieved (a) when all punch list items are accounted for by their completion or correction by the Contractor and acceptance by the Engineer and the Owner and, (b) all then-known warranty items have been satisfactorily addressed.

41.5 Acceptance of final payment by the Contractor shall be, and shall operate as, a release of the Owner from all claims and all liability to the Contractor for all things done or furnished in connection with the work, and for every act and neglect of the Owner and others relating to or arising out of the work. No payments, final or otherwise, shall release the Contractor or his/her sureties from any obligations under this Contract or under the Performance and Payment Bonds.

42. TESTS AND INSPECTIONS

42.1 Tests, inspections and approvals of portions of the work required by the Contract Documents or by laws, ordinances, rules, regulations or orders of public authorities having jurisdiction shall be made at appropriate times. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with an independent testing entity acceptable to the Engineer, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals.

43. TESTING OF COMPLETED WORK

43.1 After completion of the work and before acceptance of the work by the Owner, the Contractor shall perform all tests as required by the Specifications. The cost of all labor, tools, materials and equipment necessary for making the required tests, including the initial supply of treatment chemicals from a vendor approved by the Engineer, shall be borne by the Contractor. Any work found to be defective, faulty, or otherwise unsatisfactory shall be corrected by the Contractor without additional compensation. All work shall be guaranteed against defects as provided in the Contract Documents.

44. INCIDENTALS ABSORBED

44.1 All work and material covered by the Specifications or the Drawings, and any work, materials, or equipment that may be reasonably inferable from the information given upon Drawings or in the Specifications and that is necessary to complete the work or for the work to function and perform as intended, together with any tools, or appliances, or structures that may be needed or constructed by the Contractor for carrying out the work, shall be furnished by the Contractor, and the cost of all of the above shall be included in and absorbed by the prices and amounts included in the Contractor's Proposal.

44.2 The Contractor shall arrange and pay for all water, power, gas, sewer, telephone, cable, or other utility services used in his/her construction operations. The Contractor shall also establish and pay for all temporary/permanent utility services for the work until acceptance of the completed work by the Owner.

45. ASSIGNMENT OF CONTRACT

45.1 The Contractor shall not assign his/her Contract, nor any part thereof, nor any monies due, or to become due hereunder, without prior written consent of the Owner. In case the Contractor, with the consent of the Owner, assigns any or all of any monies due or to become due under this Contract, the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of the assignee in and to any monies due or to become due to the Contractor shall be subject to valid claims of all persons, firms, and corporations for services rendered or materials supplied for the performance of work under this Contract.

46. ORAL AGREEMENTS

46.1 No oral order, objection, claim or notice given by any party to the others shall affect or modify any of the terms or obligations contained in any of the Contract Documents, and no condition, requirement, obligation, right, or remedy in the Contract Documents shall be held to be waived or modified by reason of any act whatsoever, other than by a definitely agreed upon waiver or modification made in writing and signed by the party against whom the waiver or modification is to be enforced, and no evidence of any other waiver or modification shall be introduced in any proceeding.

47. NOTICE AND SERVICE THEREOF

47.1 All notices, demands, requests, instructions, approvals and claims shall be in writing.

47.2 Any notice to or demand upon the Contractor shall be sufficiently given if actually received (including receipt via email) or if delivered at the local office of the Contractor, or by personal service upon the Contractor's superintendent or project manager assigned to the work, or by certified or registered United States mail in a properly addressed sealed envelope with sufficient postage prepaid, or by delivery to a reputable overnight courier with charges prepaid and addressed to the Contractor at the address stated by the Contractor in the Proposal, or at the local address used by the Contractor during the process of the work (or at such other address as the Contractor may from time to time designate to the Owner in writing). Any notice to or demand upon the Owner shall be sufficiently given only if delivered to both the Owner and the Engineer at the addresses provided in the Contract Documents by one of the methods described above.

48. SUSPENSION OF WORK

48.1 The Owner shall have the right to suspend the work, wholly or in part, for such periods of time as he may deem necessary. The Contractor may be eligible for an equitable adjustment of the time for completion and/or the Contract Amount for direct costs or delays unavoidably caused solely by the suspension, unless the suspension was attributable in whole or in part to the performance or non-performance of the Contractor or unless an adjustment in the time for completion or the Contract Amount is made or denied under another provision of the Contract Documents.

49. TERMINATION FOR BREACH

49.1 In the event that the Contractor (including his/her subcontractors or vendors of any tier) violates or fails strictly to comply with any obligation or requirement in the Contract Documents, the Owner may serve written notice upon the Contractor and his/her surety of its intention to terminate the Contract or exercise any other remedy allowed by or

provided in the Contract Documents, such notices to be signed by the Owner and to contain the reasons for such intentions. Unless within ten days after serving of such notice upon the Contractor such violation or non-compliance is cured in a manner satisfactory to the Owner and the Engineer, the Owner exercise any remedy allowed by or provided in the Contract Documents, or the Owner may terminate the Contract by giving to the Contractor notice of such termination for the reasons stated in the initial notice. In the event of any such termination, the Owner shall immediately serve notice thereof upon the Contractor's surety.

49.2 The Owner may terminate the Contract if the Contractor persistently fails to supply enough properly skilled workers or proper materials; fails to maintain the construction schedule; persistently performs faulty or defective work; fails to promptly remedy any faulty work or defective work; fails to make payment to subcontractors, suppliers, or vendors for materials or labor; disregards laws, ordinances or regulations of a public authority having jurisdiction; or otherwise is guilty of substantial breach of a provision of the Contract Documents.

50. ADDITIONAL OR SUBSTITUTE BONDS

50.1 If, at any time after the execution of the Contract Agreement and the Surety Bonds attached thereto, the Owner should, for justifiable cause, deem the Surety or Sureties then upon the Performance and/or Payment Bonds, to be unsatisfactory, the Contractor shall within five (5) days after notice from the Owner to do so, furnish an acceptable bond (or bonds) in such form as may be satisfactory to the Owner and with such Surety or Sureties as may be satisfactory to the Owner. The premiums on such bond (or bonds) shall be paid for by the Contractor. No further payments to the Contractor shall be deemed to be due until such new and/or additional security for the performance of the work and/or for the payment for labor and materials shall have been furnished in form and amount satisfactory to the Owner.

51. HAZARDOUS MATERIALS

51.1 The term "hazardous materials" shall mean any substances, including but not limited to asbestos, toxic or hazardous waste, PCBs, combustible gases and materials, petroleum or radioactive materials (as each of these is defined in applicable federal statutes) or any other substances under any conditions and in such quantities as would pose a substantial danger to persons or property exposed to such substances at or near the work site.

51.2 If reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a hazardous material encountered at the site, then the Contractor shall, upon recognizing the condition, immediately stop work in the affected area and report the condition to the Owner and Engineer in writing.

51.3 The Contractor is responsible for being aware of and complying with the Asbestos National Emission Standard for Hazardous Air Pollutants (NESHAP). The Contractor shall perform all work activities in accordance with the Asbestos NESHAP regulation and any other applicable federal, state or local codes, laws, and regulations.

52. SCHEDULE OF WORK

52.1 All activities associated with the work requiring partial or complete shutdown of the existing facilities shall be scheduled by the Contractor and approved the Owner. The schedule approved by the Owner must include the exact time and duration of any and all periods of shutdown of the existing facilities. Review and approval of schedule by Engineer/Owner

is for general compliance with Contract requirements and Contractor shall remain solely responsibel for developing and updating the schedule, identifying sequence of work, conflicts, work restrictions, and phasing, all as required to meet the completion dates.

Certificate of Substantial Completion

Date of Issuance: _____

Project Name: Shenandoah Wastewater Treatment Facility Improvements

Project Number: 20518

Owner: Coweta County Water & Sewerage Authority

Contractor: _____

☐ This Certificate of Substantial Completion applies to **all** work under the Contract Documents

☐ This Certificate of Substantial Completion applies **only** to the following specified parts of the Contract Documents

_____

_____

_____

_____

_____

The work to which this Certificate applies has been reviewed by authorized representatives of the Owner, Contractor, and Engineer, and found to be substantially complete as of the date stated below. The date below is also the date of commencement of warranties for the items (if any) included in the attached list.

The Work described herein is declared to be substantially complete on _____

☐ A "Punch-List" of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include an item in it does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. The items in the list shall be completed or corrected by the Contractor within 10 days of the above date of Substantial Completion.

☐ A list of excepted Warranty items is attached hereto.

Signed: _____

GEORGIA ENVIRONMENTAL FINANCE AUTHORITY

SUPPLEMENTAL GENERAL CONDITIONS

for

FEDERALLY ASSISTED
STATE REVOLVING FUND
CONSTRUCTION CONTRACTS

May 9, 2014

The following standard language must be incorporated into construction contract documents and in all solicitations for offers and bids for all construction contracts or subcontracts in excess of $10,000 to be funded in whole or in part by the federally-assisted State Revolving Fund in the state of Georgia.

These Supplemental General Conditions shall not relieve the participants in this project of responsibility to meet any requirements of other portions of this construction contract or of other agencies, whether these other requirements are more or less stringent. The requirements in these Supplemental General Conditions must be satisfied in order for work to be funded with the State Revolving Fund.

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INSTRUCTIONS & GENERAL REQUIREMENTS

It is the policy of the State Revolving Loan Fund (SRF) to promote a fair share of subcontract, materials, equipment and service awards to small, minority, and women-owned businesses for equipment, supplies, construction, and services. Compliance with these contract provisions is required in order for project costs to be eligible for SRF funding. The fair share objective is a goal, not a quota. Failure on the part of the apparent successful bidder to submit required information to the loan recipient (Owner) may be considered by the Owner in evaluating whether the bidder is responsive to bid requirements.

THE PRIME CONTRACTOR MUST SUBMIT THE FOLLOWING ITEMS TO THE OWNER:

A. Before beginning the work of any contract:

1) DBE Compliance Form and related documentation. The Owner must submit this information to the Georgia Environmental Finance Authority (GEFA) to demonstrate compliance with Disadvantaged Business Enterprise (DBE) requirements. GEFA concurrence is recommended prior to award of the construction contract and is required prior to commencement of any SRF-funded construction. (Pages GEFA-4&5)
2) Certification Regarding Equal Employment Opportunity. This form is required for the Prime Contractor and for all subcontractors. The Prime Contractor form should be submitted with the DBE Compliance Form, and the subcontractor forms should be submitted as the subcontracts are executed. (Page GEFA-9)
3) Certification Regarding Debarment, Suspension, & Other Responsible Matters. This form is required for the Prime Contractor and for all subcontractors. The Prime Contractor form should be submitted with the DBE Compliance Form and the subcontractor forms should be submitted as the subcontracts are executed. (Page GEFA-10)
4) *EPA Form 6100-2 DBE Subcontractor Participation Form. This form gives a DBE subcontractor the opportunity to describe the work the DBE subcontractor received from the Prime Contractor, how much the DBE subcontractor was paid, and any concerns the DBE subcontractor might have. The Prime Contractor must provide this form to each DBE subcontractor. The DBE subcontractor can, as an option, complete and submit this form to the GEFA DBE Coordinator, who will also forward the form to the EPA DBE Coordinator. (Page GEFA-11)
5) *EPA Form 6100-3 DBE Subcontractor Performance Form. This form captures the description of work to be performed by an intended DBE subcontractor and the price of the work. This form is to be provided by the Prime Contractor to each DBE subcontractor and submitted with the DBE Compliance Form. (Page GEFA-12)
6) *EPA Form 6100-4 DBE Subcontractor Utilization Form. This form captures intended or anticipated use of an identified DBE subcontractor by the Prime Contractor and the estimated dollar amount of the work. This form is to be completed by the Prime Contractor and submitted with the DBE Compliance Form. (Page GEFA-13)

* 6100 FORMS ARE NOT REQUIRED WHEN ALL OF THE WORK IS SELF-PERFORMED BY THE PRIME CONTRACTOR.

B. During the performance of the contract:

7) Changes to Subcontractors Form. If any changes, substitutions, or additions are proposed to the subcontractors included in previous GEFA concurrences, the Owner must submit this information to GEFA for prior concurrence in order for the affected subcontract work to be eligible for SRF funding. (Page GEFA-14)
8) DBE Annual Report. The Owner must submit this information to GEFA no later than October 20th of any year that the construction contract is active. (Page GEFA-15)
9) Certified Payrolls. These should be submitted to the Owner weekly for the Prime Contractor and all subcontractors. The Owner must maintain payroll records and make these available for inspection. Use Department of Labor form WH-347 or a similar form that contains all of the information on the Department of Labor.

THE OWNER MUST SUBMIT INFORMATION FOR GEFA REVIEW AND CONCURRENCE TO:

Georgia Environmental Finance Authority
Attention: DBE Compliance Coordinator
233 Peachtree Street, N.E.
Harris Tower, Suite 900
Atlanta, Georgia 30303
(404)584-1000; (404)584-1069 (fax)
dbe_compliance@gefa.ga.gov

DBE COMPLIANCE FORM

ALL INFORMATION OUTLINED ON THIS FORM IS REQUIRED FOR DBE COMPLIANCE REVIEW. THE PROPOSED PRIME CONTRACTOR AND OWNER SHOULD ENSURE THAT THIS INFORMATION IS COMPLETE PRIOR TO SUBMITTAL.

Loan Recipient _____ SRF Loan Number _____

PRIME CONTRACTOR'S AND OWNER'S CERTIFICATIONS:

I certify that the information submitted on and with this form is true and accurate and that this firm has met and will continue to meet the conditions of this construction contract regarding DBE solicitation and utilization. I further certify that criteria used in selecting subcontractors and suppliers were applied equally to all potential participants and that EPA Forms 6100-2 and 6100-3 were distributed to all DBE subcontractors.

_____ Date_____

(Prime Contractor signature)

_____

(Printed name and title)

I certify that I have reviewed the information submitted on and with this form and that it meets the requirements of the Owner's State Revolving Fund loan contract.

_____ Date_____

(Signature of Owner or Owner's representative)

_____

(Printed name and title)

CONTACT INFORMATION

Owner contact _____

Owner phone number & email _____

Consulting Engineer contact _____

Consulting Engineer phone number & email _____

Proposed Prime Contractor _____

Prime Contractor contact _____

Prime Contractor phone number & email _____

Proposed total contract amount $ _____

Proposed total MBE participation $ _____Percentage _____ Goal: 4.0 percent

Proposed total WBE participation $ _____Percentage _____ Goal: 4.0 percent

CONTINUED ON NEXT PAGE

Please submit the following with the DBE Compliance Form:

1) List of all committed and uncommitted subcontractors by trade, including company name, address, telephone number, contact person, dollar amount of subcontract, and DBE/MBE/WBE status.

2) Indicate in writing if no solicitations were made because the Prime Contractor intends to use only its own forces to accomplish the work.

3) Proof of certification by EPA, SBA, DOT (or by state, local, Tribal, or private entities whose certification criteria match EPA criteria) for each subcontractor listed as a DBE, MBE, or WBE.

4) Documentation of solicitation efforts for prospective DBE firms, such as fax confirmation sheets, copies of solicitation letters and e-mails, printout of online solicitations, printouts of online search results and copies and affidavits of publication in newspapers or other publications. (see also, "Six Good Faith Efforts", page GEFA-7).

    a. The Prime Contractor shall use the necessary resources to identify and directly solicit no less than 3 certified MBE firms and 3 certified WBE firms to bid in each expected subcontract trade or area. If a diligent and documented search of the recommended directories does not identify 3 potential certified MBE firms and 3 potential certified WBE firms, then the Prime Contractor shall post an advertisement in the Owner's local legal organ, the Owner's official website, a regional newspaper in a larger community in the proximity, the Prime Contractor's website, or some other appropriate resource.
    b. The Prime Contractor is encouraged to follow-up each written, fax, or e-mail solicitation with at least 1 logged phone call.
    c. Whenever possible, post solicitations for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

5) Written justification for not selecting a certified DBE subcontractor that submitted a low bid for any subcontract area.

6) Certification By Proposed Prime Contractor or Subcontractor Regarding Equal Employment Opportunity (GEFA-9)

7) Certification By Proposed Prime or Subcontractor Regarding Debarment, Suspension, and Other Responsible Matters. (GEFA-10)

8) *EPA Form 6100-3 DBE Subcontractor Performance Form for all DBE subcontracts. (GEFA-12)

9) *EPA Form 6100-4 DBE Subcontractor Utilization Form for all DBE subcontracts. (GEFA-13)

*6100 forms are not required when all of the work is self-performed by the prime contractor.

END OF DBE COMPLIANCE FORM

DBE COMPLIANCE CHECKLIST

THE PRIME CONTRACTOR MUST SUBMIT THE FOLLOWING ITEMS TO THE OWNER BEFORE THE WORK BEGINS:

Loan Recipient _____ SRF Loan Number _____

Include in Package Submittal

PRIME CONTRACTOR ONLY	TOTAL CONTRACT AMOUNT

ALL SUBCONTRACTORS, INCLUDING DBE FIRMS	TRADE	AMOUNT

ALL SUBCONTRACTORS, INCLUDING DBE FIRMS	TRADE	AMOUNT

DBE SUBCONTRACTORS ONLY	TRADE	AMOUNT

DBE SUBCONTRACTORS ONLY	TRADE	AMOUNT

PRIME CONTRACTOR ONLY *(Not applicable if self-performing all work, with no subcontracting)*

1. DBE Compliance Form. The Owner must sign and submit this information to the Georgia Environmental Finance Authority (GEFA) to demonstrate compliance with DBE requirements. GEFA concurrence is recommended prior to award of the construction contract and is required prior to commencement of any SRF-funded construction. (Pages GEFA-4&5)

2. Certification Regarding Equal Employment Opportunity. This form is required for the Prime Contractor and for all subcontractors. The Prime Contractor's form should be submitted with the DBE Compliance Form and the subcontractors' forms should be submitted as the subcontracts are executed. (Page GEFA-9)

3. Certification Regarding Debarment, Suspension, & Other Responsible Matters. This form is required for the Prime Contractor and for all subcontractors. The Prime Contractor's form should be submitted with the DBE Compliance Form and the subcontractors' forms should be submitted as the subcontracts are executed. (Page GEFA-10)

4. EPA Form 6100-2 DBE Subcontractor Participation Form. This form gives a DBE subcontractor the opportunity to describe the work the DBE subcontractor received from Prime Contractor, how much the DBE subcontractor was paid, and any other concerns the DBE subcontractor might have. The Prime Contractor must provide this form to each DBE subcontractor. The DBE subcontractor can, as an option, submit this form to the GEFA DBE Coordinator, who will forward the form to the EPA DBE Coordinator. (Page GEFA-11)

5. EPA Form 6100-3 DBE Subcontractor Performance Form. This form captures an intended DBE subcontractor's description of work to be performed for the Prime Contractor and the price of the work. This form is to be provided by the Prime Contractor to each DBE subcontractor and submitted with the DBE Compliance Form. (Page GEFA-12)

6. EPA Form 6100-4 DBE Subcontractor Utilization Form. This form captures the Prime Contractor's intended use of an identified DBE subcontractor and the estimated dollar amount of the work. This form is to be completed by the Prime Contractor and submitted with the DBE Compliance Form (Page GEFA-13)

Uncommitted Trades

Documentation of Good Faith Efforts

Newspaper ads		Internet Websites	Fax Confirmation	Copies of Solicitation Emails/letters	Copies of phone logs
PROOF OF CERTIFICATION FOR EACH SUBCONTRACTOR LISTED AS A DBE, MBE, OR WBE					

SIX GOOD FAITH EFFORTS

These good faith efforts are required methods to ensure that DBEs have the opportunity to compete for procurements funded by EPA financial assistance dollars. Such good faith efforts are described as follows:

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. This will include placing DBEs on solicitation lists and soliciting them whenever there are potential sources.

2. Make information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. This includes, whenever possible, posting solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

3. Consider in the contracting process whether firms competing for large contracts could subcontract with DBEs. This will include dividing total requirements when economically feasible into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.

4. Encourage contracting with a consortium of DBEs when a contract is too large for one of these firms to handle individually.

5. Use the resources, services, and assistance of the Department of Transportation (DOT), Small Business Administration (SBA), and the Minority Business Development Agency of the Department of Commerce (MBDA).

6. If the Prime Contractor awards subcontracts, it must take the steps described in items (1) through (5) listed above.

Please note that DBEs, MBEs, and WBEs must be certified by EPA, SBA, or DOT (or by state, local, Tribal, or private entities whose certification criteria match EPA's). DBEs must be certified in order to be counted toward the Prime Contractor's MBE/WBE goals. "Self-certified" DBE subcontractors will not be counted toward the Prime Contractor's MBE/WBE goals. Depending upon the certifying agency, a DBE may be classified as a DBE, a Minority Business Enterprise (MBE), or a Women's Business Enterprise (WBE).

The Prime Contractor must employ and document the Six Good Faith Efforts for all subcontracts, even if the Prime Contractor has achieved the fair share objectives.

The documentation of solicitations for the Six Good Faith Efforts must be detailed in order to allow for satisfactory review. Such documentation might include fax confirmation sheets, copies of solicitation letters/emails, printouts of the online solicitations, printouts of online search results and affidavits of publication in newspapers or other publiccations. The Prime Contractor is encouraged to follow up each written, fax, or e-mail solicitation with at least 1 logged phone call.

The Prime Contractor should attempt to identify and solicit DBEs in the geographic proximity of the project before soliciting those located farther away.

If a DBE subcontractor fails to complete work under the subcontract for any reason, the Prime Contractor must notify the Owner in writing prior to any termination and must employ the Six Good Faith Efforts described above if using a replacement subcontractor. Any proposed changes from the approved DBE subcontractor list must be reported to the Owner and to GEFA on the *Changes to Approved Subcontractors Form* (GEFA-14) prior to initiation of the action. EPA Forms Nos. 6100-3 and 6100-4 must also be submitted to GEFA for new DBE subcontracts.

RESOURCES FOR IDENTIFYING DBE SUBCONTRACTORS

RESOURCES FOR IDENTIFYING DBE SUBCONTRACTOR'S FOR DIRECT SOLICITATION:

Georgia Department of Transportation (GDOT)
Disadvantaged Business Enterprise Program
(404) 631-1972
https://gdotbiext.dot.ga.gov/analytics/saw.dll?Dashboard&PortalPath=%2Fshared%2FExternal%2F_portal%2FUCP%20Directory&Page=UCP%20Directory&Action=Navigate&Syndicate=true&anon=1

City of Atlanta, Georgia Office of Contract Compliance (404) 330-6010
https://www.atlantaga.gov/government/mayor-s-office/executive-offices/office-of-contract-compliance

DeKalb County, Georgia
Office of Purchasing and Contracting
(404) 371-4730
http://dekalblsbe.info/wordpress1/wp-content/uploads/2016/05/DeKalbCountyCertifiedVendorsListMay10-2016-Final2.pdf

Fulton County, Georgia
Purchasing and Contract Compliance
(404) 612-5800
http://www.fultoncountyga.gov/fcpccd-local-business-directory

Metropolitan Atlanta Rapid Transit Authority (MARTA)
Disadvantaged Business Enterprise Program
(404) 848-4656
https://marta.diversitysoftware.com/FrontEnd/VendorSearchPublic.asp?XID=8663&TN=marta

United States Environmental Protection Agency
http://www.epa.gov/osbp/dbe_team.htm
Teree Henderson
National DBE Program Coordinator
(202) 566-2222
henderson.teree@epa.gov

For more information about DBE compliance, contact:
dbe_compliance@gefa.ga.gov

NOTES:

(1) The Prime Contractor shall use the necessary resources to identify and directly solicit no less than 3 certified MBE firms and 3 WBE firms to bid in each expected subcontract area or trade.

(2) If a diligent and documented search of the recommended directories does not identify 3 potential certified MBE firms and 3 potential certified WBE firms, then the Prime Contractor shall post an advertisement in the Owner's local legal organ, the Owner's official website, a regional newspaper in a larger community in the proximity, the Prime Contractor's website, or some other appropriate resource. Whenever possible, post solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

(3) Expenditures to a DBE that acts merely as a broker or passive conduit of funds, without performing, managing, or supervising the work of its subcontract in a manner consistent with normal business practices may not be counted.

(4) The Prime Contractor should attempt to identify and first solicit DBEs in the geographic proximity of the project before soliciting those located farther away.

(5) Contact GEFA Program Managers at (404) 584-1000 or dbe_compliance@gefa.ga.gov for further assistance or resources.

CERTIFICATION BY PROPOSED PRIME CONTRACTOR OR SUBCONTRACTOR REGARDING EQUAL EMPLOYMENT OPPORTUNITY

Proposed Prime Contractor
Proposed Subcontractor

This certification is required pursuant to Executive Order 11246, Part II, Section 203 (b), (30 F.R. 12319-25). Any bidder or prospective prime contractor, or any of the proposed subcontractors, shall state as an initial part of the bid or negotiations of the contract whether it has participated in any previous contract or subcontract subject to the equal opportunity clause; and, if so, whether it has filed all compliance reports due under applicable instructions.

Where the certification indicated that the prime or subcontractor has not filed a compliance report due under applicable instruction, such contractor shall be required to submit a compliance report.

(1) Bidder has participated in a previous contract or subcontract subject to the Equal Opportunity Clause.
YES _____ NO _____

(2) Compliance Reports were required to be filed in connection with such contract or subcontract.
YES _____ NO _____ (If YES, state what reports were filed and with what agency.)

(3) Bidder has filed all compliance reports due under applicable instructions, including SF-100 (EEO-1 Report).
YES _____ NO _____ (If NO, please explain in detail.)

The information above is true and complete to the best of my knowledge and belief. (A willfully false statement is punishable by law – U.S. Code, Title 18, Section 1001.)

_____
PRINTED NAME & TITLE OF AUTHORIZED REPRESENTATIVE OF CONTRACTOR OR SUBCONTRACTOR

_____ _____
SIGNATURE OF AUTHORIZED REPRESENTATIVE DATE

CERTIFICATION BY PROPOSED PRIME CONTRACTOR OR SUBCONTRACTOR REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBLE MATTERS

Proposed Prime Contractor
Proposed Subcontractor

Under Executive Order 12549 individuals or organizations debarred from participation in Federal Assistance Programs may not receive an assistance award under federal program or sub-agreement there under for $25,000 or more. Accordingly each recipient of a State loan or a contract (engineering or construction) awarded under a loan must complete the following certification (see 40 CFR 32.510).

The prospective participant certifies to the best of its knowledge and belief that it and its principals;

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency.

(b) Have not within a three year period preceding this proposal been convicted of or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1) (b) of this certification; and

(d) Have not within a three year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause of default.

I understand that a false statement on this certification may be grounds for rejection of this proposal or termination of the award. (A willfully false statement is punishable by law – U.S. Code, Title 18, Section 1001.)

_____

PRINTED NAME & TITLE OF AUTHORIZED REPRESENTATIVE OF CONTRACTOR OR SUBCONTRACTOR

_____ _____

SIGNATURE OF AUTHORIZED REPRESENTATIVE DATE

_____ I am unable to certify to the above statements. My explanation is as follows:

OMB Control No: 2090-0030
Approved: 8/13/2013
Approval Expires: 8/31/2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

An EPA Financial Assistance Agreement Recipient must require its prime contractors to provide this form to its DBE subcontractors. This form gives a DBE[1] subcontractor[2] the opportunity to describe work received and/or report any concerns regarding the EPA-funded project (e.g., in areas such as termination by prime contractor, late payments, etc.). The DBE subcontractor can, as an option, complete and submit this form to the EPA DBE Coordinator at any time during the project period of performance.

Subcontractor Name		Project Name
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Prime Contractor Name		Issuing/Funding Entity:

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services , Equipment or Supplies	Amount Received by Prime Contractor

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

United States Environmental Protection Agency

OMB Control No: 2090-0030
Approved: 8/13/2013
Approval Expires: 8/31/2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

This form is intended to capture the DBE[1] subcontractor's[2] description of work to be performed and the price of the work submitted to the prime contractor. An EPA Financial Assistance Agreement Recipient must require its prime contractor to have its DBE subcontractors complete this form and include all completed forms in the prime contractors bid or proposal package.

Subcontractor Name	Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.	Email Address	
Prime Contractor Name	Issuing/Funding Entity:	

Contract Item Number	Description of Work Submitted to the Prime Contractor Involving Construction, Services , Equipment or Supplies	Price of Work Submitted to the Prime Contractor
DBE Certified By: ___ DOT ___SBA ___ Other: _____	Meets/ exceeds EPA certification standards? ___YES ___NO ___Unknown	

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

United States Environmental Protection Agency

OMB Control No: 2090-0030
Approved: 8/13/2013
Approval Expires: 8/31/2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form

This form is intended to capture the prime contractor's actual and/or anticipated use of identified certified DBE[1] subcontractors[2] and the estimated dollar amount of each subcontract. An EPA Financial Assistance Agreement Recipient must require its prime contractors to complete this form and include it in the bid or proposal package.
Prime contractors should also maintain a copy of this form on file.

Prime Contractor Name		Project Name
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Issuing/Funding Entity:		

I have identified potential DBE certified subcontractors	___ YES	___ NO
If yes, please complete the table below. If no, please explain:		

Subcontractor Name/ Company Name	**Company Address/ Phone/ Email**	**Est. Dollar Amt**	**Currently DBE Certified?**

Continue on back if needed

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

CHANGES TO APPROVED SUBCONTRACTORS FORM

Loan Recipient _____ SRF Loan Number _____

CERTIFICATIONS:
I certify that the information submitted on and with this form is true and accurate and that this firm has met and will continue to meet the conditions of this construction contract regarding DBE solicitation and utilization. I further certify that criteria used in selecting subcontractors and suppliers were applied equally to all potential participants.

_____ Date_____
(Prime Contractor signature)

_____
(Printed name and title)

I certify that I have reviewed the information submitted on and with this form and that it meets the requirements of the Owner's State Revolving Fund loan contract.

_____ Date_____
(Signature of Owner or Owner's representative)

_____
(Printed name and title)

GENERAL INFORMATION:

1) If an approved subcontractor is terminated or replaced, please identify this company and briefly state reason.

Subcontractor Name::	Trade
Reason Terminated or Replaced	

2) For new or additional subcontractors, list name, trade, address, telephone number, contact person, dollar amount of subcontract, and DBE status.

New Subcontractor Name and Contact Person	Trade
Address	Telephone Number
Dollar Amount	DBE Status

1) Attach proof of certification by EPA, SBA, DOT (or by state, local, Tribal, or private entities whose certification criteria match EPA's) for each subcontractor listed as a DBE, MBE, or WBE.

2) Attach documentation of Six Good Faith Efforts solicitation effort for all new subcontracts.

3) Provide justification for not selecting any certified DBE subcontractor that submitted a low bid for any subcontract area.

4) For each subcontractor, attach certifications regarding Equal Employment Opportunity (GEFA-9) and certifications regarding Debarment, Suspension, and Other responsible Matters (GEFA-10)

DBE ANNUAL REPORT
FORM (5700-52A)

This form must be completed by recipients of federal financial assistance for procurement of supplies, equipment, construction or services. SRF loan recipients are required to submit this report to GEFA by the 20th of October for the previous period of October 1 through September 30. Please submit a "negative" report even if $0 is the amount paid to MBE/WBE subcontractors during the reporting period.

ANNUAL REPORT FORM (5700-52A)			
1. PRIME CONTRACTOR	**2. REPORTING PERIOD (Complete date using current year.)** **Period Ending (September 30, _____)**		
3. SUBMIT TO: Georgia Environmental Finance Authority Attention: DBE Compliance Coordinator 233 Peachtree Street, N.E. Harris Tower, Suite 900 Atlanta, Georgia 30303 dbe_compliance@gefa.ga.gov	**4. LOAN RECIPIENT (Name, Address and Telephone)**		
5. LOAN RECIPIENT (OWNER) REPORTING CONTACT	**PHONE:**	**6. TYPE OF FEDERAL FINANCIAL ASSISTANCE PROGRAM (Check one)** **CWSRF _____ DWSRF_____**	**7. SRF LOAN NUMBER**
8. CONTRACTOR NAME & TOTAL CONSTRUCTION CONTRACT AMOUNT	**9. ACTUAL DOLLAR AMOUNT PAIDTO MBE/WBE SUBCONTRACTORS THIS PERIOD** **$ MBE_____ $ WBE_____ NEGATIVE REPORT ($0) ___**		
10. RECIPIENT'S MBE/WBE GOALS **MBE** 4.0 **%** **WBE** 4.0 **%**	**11. TOTAL DOLLARS SPENT THIS PERIOD** **MBE $_____** **WBE $_____** **NON MBE/WBE $_____** **TOTAL $ _____**		
12. NAME & TITLE OF AUTHORIZED REPRESENTATIVE OF LOAN RECIPIENT (OWNER).	**13. SIGNATURE OF AUTHORIZED REPRESENTATIVE OF LOAN RECIPIENT.**	**14. DATE**	

MBE/WBE PAYMENTS MADE DURING PERIOD	
NAME & ADDRESS of DBE (SUB)CONTRACTOR (indicate if MBE or WBE firm)	TOTAL DOLLAR AMOUNT PAID & DATE PAID **$_____ DATE_____**

SPECIAL PROVISIONS

(a) The Prime Contractor is required to pay its subcontractors in accordance with the Georgia Prompt Payment Act (OCGA 13-11).

(b) The Prime Contractor is required to insert the entirety of the Davis Bacon contract requirements into all subcontracts

(c) Sewer line and water line crossing of all roads and streets shall be done in accordance with the Georgia Department of Transportation (D.O.T.) Policies and Procedures and must comply with the Ga. D.O.T. Standard Specifications, Construction of Roads and Bridges, 1993 Edition.

(c) Construction shall be carried out so as to prevent bypassing of wastewater flow and to prevent interruption of drinking water treatment during construction. EPD must receive written notification prior to any reduction in the level of treatment and must approve all temporary modifications to the treatment process prior to the activity.

(d) Erosion and Sedimentation Control shall be accomplished in accordance with the Georgia Erosion and Sedimentation Control Act of 1975 as currently amended and NPDES General Permits (Storm Water from Construction Sites). See also www.gaepd.org and www.gaswcc.georgia.gov for information regarding permits.

(e) Use of Chemicals: All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer reactant or of other classification, must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be in conformance with State and local regulations as appropriate.

(f) It is the duty of the Prime Contractor, the Owner and the Engineer to ensure the construction of the project, including the letting of contracts in connection therewith, shall comply with all applicable laws and regulations and requirements of the United States of America or any agency thereof, the state of Georgia or any agency thereof, territorial, or any local government laws or political subdivision and ordnances to the extent that such requirements do not conflict with Federal laws and this subchapter.

(g) EPD, EPA, and GEFA shall have access to the site and the project work at all times.

BONDS

Bonding requirements for Contracts of $100,000 or less are contained in the General Conditions. Bond requirements of contracts in excess of $100,000 are:

1. Bid guarantee equivalent to five percent of the bid price. The bid guarantee shall consist of a firm commitment such as a certified check or bid bond submitted with the bid.

2. Performance bond equal to 100 percent of the contract price and;

3. Payment bond equal to 100 percent of the contract price. Bonds must be obtained from companies holding Certificates of Authority as acceptable sureties, issued by the U.S. Treasury.

SPECIAL NOTICE TO BIDDERS

By the submission of this bid, each bidder acknowledges that he understands and agrees to be bound by the equal opportunity requirements of EPA regulations (40 CFR Part 8, particularly Section 8.4 (b)), which shall be applicable throughout the performance of work under any contract awarded pursuant to this solicitation. Each bidder agrees that if awarded a contract, it will similarly bind contractually each subcontractor. In implementation of the foregoing policies, each bidder further understands and agrees that if awarded a contract, it must engage in affirmative action directed at promoting and ensuring equal employment opportunity in the workforce used under the contract (and that it must require contractually the same effort of all subcontractors whose subcontracts exceed $10,000.00). The bidder understands and agrees that “affirmative action” as used herein shall constitute a good faith effort to achieve and maintain minority employment in each trade in the on-site workforce used on the project.

EQUAL EMPLOYMENT OPPORTUNITY NOTICE

NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL OPPORTUNITY
(EXECUTIVE ORDER 11246)

1. The Offeror's or Bidder's attention is called to the Equal Opportunity Clause which is included in the nondiscrimination Provision and Labor Standards, EPA Form 5720-4 and the Standard Federal Equal Employment Opportunity (EEO) Construction Contract Specifications set forth herein.

2. The goals for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Goals for minority participation for each trade	4.0 percent
Goals for female participation for each trade	4.0 percent

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals established for the geographical area where the contract resulting from this solicitation is to be performed. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minority and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation to the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The contractor shall not discriminate on the basis of race, color, national origin or sex in the performance of this contract. The contractor shall carry out applicable requirements of 40CFR Part 33 in the award and administration of contracts awarded under EPA financial assistance agreements. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract.

4. As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is (insert description of the geographical area where the contract is to be performed giving the state, county and city, if any).

EEO Construction Contract Specifications (Executive Order 11246)

EEO Specifications:

1. As used in these specifications:

   a. "Covered area" means the geographical area described in the solicitation from which this contract resulted;

   b. "Director" means Director, Office of Federal Contract Compliance Program, United States Department of Labor, or any person to whom the Director delegates authority;

   c. "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form, 941.

   d. "Minority" includes:

      (i) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);

      (ii) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);

      (iii) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and

      (iv) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

2. Whenever the contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

3. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7(a) through (p) of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. The Contractor is expected to make substantially uniform progress toward its goals in each craft during the period specified.

5. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

6. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

7. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

   a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

   b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations ☐ responses.

   c. Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefore, along with whatever actions the Contractor may have taken.

   d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

   e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trained programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources complied under 7(b) above.

   f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with on-site supervisory personnel such as Superintendents, General Foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.

i. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's workforce.

k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.

m. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.

n. Ensure that all facilities and company activities are non-segregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

p. Conduct a review, at least annually, of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

8. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations 7(a) through (p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the contractor is a member and participant may be asserted as fulfilling any one or more of its obligations under 7(a) through (p) of these Specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes

a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

10. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

11. The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.

13. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation, if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

Davis-Bacon and Related Acts

Labor Standards Provisions for Federally Assisted Contracts

Contract Provision for Contracts in Excess of $2,000.

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's web site, http://www.dol.gov/whd/govcontracts/dbra.htm (E-tools)

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The State award official shall approve a request for an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), documentation of the action taken and the request, including the local wage determination shall be sent by the subrecipient (s) to the State award official. The State award official will transmit the request, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210 and to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification request within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the request and the local wage determination, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The request shall be sent to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt of the request and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s), shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the sub-grant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly

payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/whd/forms or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees--

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed.

In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may by appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination; debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the

meaning of this clause include disputes between the contractor (or any of its subcontractors) and Subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

Contract Provision for Contracts in Excess of $100,000.

(a) Contract Work Hours and Safety Standards Act. The subrecipient shall insert the following clauses set forth in paragraphs (a)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Item 3, above or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (a)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a)(1) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (a)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient, upon written request of the EPA Award Official or an authorized representative of the Department of Labor, shall withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (a)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (a)(1) through (4) of this section.

(b) In addition to the clauses contained in Item 3, above, in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, the Subrecipient shall insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Subrecipient shall insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job

(5) Compliance Verification:

(a) The subrecipient shall periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. The subrecipient must use Standard Form 1445 (SF 1445) or equivalent documentation to memorialize the interviews. Copies of the SF 1445 are available from EPA on request.

(b) The subrecipient shall establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, the subrecipient should conduct interviews with a representative group of covered employees within two weeks of each contractor or subcontractor's submission of its initial weekly payroll data and two weeks prior to the estimated completion date for the contract or subcontract. Subrecipients must conduct more frequent interviews if the initial interviews or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. Subrecipients shall immediately conduct necessary interviews in response to an alleged violation of the prevailing wage requirements. All interviews shall be conducted in confidence.

(c) The subrecipient shall periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. The subrecipient shall establish and follow a spot check schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, if practicable, the subrecipient should spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract. Subrecipients must conduct more frequent spot checks if the initial spot check or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. In addition, during the examinations the subrecipient shall verify evidence of fringe benefit plans and payments thereunder by contractors and subcontractors who claim credit for fringe benefit contributions.

(d) The subrecipient shall periodically review contractors and subcontractors' use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the U.S Department of Labor or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews described in Item 5(b) and (c) above.

(e) Subrecipients must provide a report of compliance to the Georgia Environmental Finance Authority detailing compliance efforts and results. This report will be submitted with or prior to the loan recipient's first request for funding of construction costs, prior to final disbursement of funds from the loan, and as requested by the GEFA during the project.

(f) Subrecipients must immediately report potential violations of the DB prevailing wage requirements to the EPA DB coordinator and to the appropriate DOL Wage and Hour District Office listed at http://www.dol.gov/whd/america2.htm.

INSERT WAGE RATE DETERMINATION HERE

Wage Rates (for *Heavy Construction*) are state/county specific can be found at:

http://www.dol.gov/whd/govcontracts/dbra.htm

Sample Payroll Form (WH-347) is found at:

http://www.dol.gov/whd/forms/wh347.pdf

Labor Standards Interview Form (SF-1445) is found at:

http://www.gsa.gov/portal/forms/download/115910

Davis-Bacon (WH-1321) poster is found at:

http://www.dol.gov/whd/regs/compliance/posters/fedprojc.pdf
(*English*)

http://www.dol.gov/whd/regs/compliance/posters/davispan.pdf
(*Spanish*)

Fair Labor Standards Act Minimum Wage poster is found at:

http://www.dol.gov/whd/regs/compliance/posters/minwagebwp.pdf
(*English*)

http://www.dol.gov/whd/regs/compliance/posters/minwagespbwP.pdf
(*Spanish*)

"EEO Is the Law" poster is found at:

http://www.eeoc.gov/employers/upload/eeoc_self_print_poster.pdf
(*English*)

http://www.eeoc.gov/employers/upload/eeoc_self_print_poster_spanish.pdf
(*Spanish*)

"EEO Is the Law" poster supplement is found at:

http://www.eeoc.gov/employers/upload/eeoc_gina_supplement.pdf
(*English*)

http://www.eeoc.gov/employers/upload/eeoc_gina_supplement_spanish.pdf
(*Spanish*)

OSHA poster is found at:

http://www.osha.gov/Publications/osha3165low-res.pdf
(*English*)

http://www.osha.gov/Publications/osha3167.pdf
(*Spanish*)

CERTIFIED PAYROLL REVIEW CHECKLIST

(This is a *recommended Certified Payroll Review Checklist for the Owner's use*.)

CONTRACT ID City of CW/DWSRF#00 - 000	PRIME CONTRACTOR/SUBCONTRACTOR X Construction
GENERAL WAGE DECISION AND DATE (Insert number & date)	PAYROLL PERIOD ENDING

INSTRUCTIONS: This checklist is to be used in conjunction with projects requiring Davis-Bacon Wage Rates and compliance reviews. All certified payrolls are to be date stamped upon receipt from the prime contractor.

Payroll Information Checklist:

_____ Prime Contractor's or subcontractor's name and address
_____ Contract ID numbers (GEFA SRF No.)
_____ Week ending.
_____ Project location.

_____ Employee ID or Last 4 digits of Social Security Number
- _____ Social Security Number removed
- _____ Employee's work classification
- _____ Identification of OJTs, apprentices and program levels (%) on payrolls.
- _____ Verify that OJT and Apprentice Program documentation is in project files.

_____ Daily and weekly employee hours worked in each job classification.
- _____ Daily and weekly employee overtime (or premium) hours worked
- _____ Total weekly hours worked on all jobs (prevailing and non-prevailing wage).
- _____ Base rate shown for each employee, overtime (or premium) rate shown when worked.
- _____ Verify correct wage rates are being paid.
- _____ Verify overtime is being paid correctly (over 40 hrs/wk, and Time and a half)
- _____ Week's gross wages
- _____ Week's itemized deductions.
- _____ Week's net wages paid

_____ Compliance statement attached.
- _____ Method of fringe benefit payment described by checking either box (4)(a) or (4)(b).
- _____ Fringe benefit package information in file and updated as needed (if 4(a) is checked)
- _____ Exceptions explanation for fringe benefit (4)(c).
- _____ Signature.

Compliance Review Checklist (for field reviews):

_____ Verify work classifications reported are consistent with the work performed.
_____ Compare payrolls with wage rate interviews when conducted.
_____ Compare number of employees and hours worked with project documentation.

REVIEWED BY:	DATE

GEORGIA ENVIRONMENTAL FINANCE AUTHORITY

AMERICAN IRON AND STEEL
SPECIAL CONDITIONS AND INFORMATION

For

FEDERALLY ASSISTED
STATE REVOLVING LOAN FUND
CONSTRUCTION CONTRACTS

April 11, 2014

The following standard language must be incorporated into construction contract documents and in all solicitations for offers and bids for all construction contracts or subcontracts to be funded, in whole or in part, through the Federally-assisted State Revolving Fund in the State of Georgia for projects subject to the American Iron and Steel requirements.

These Special Conditions shall not relieve the participants in this project of responsibility to meet any requirements of other portions of this construction contract or of other agencies, whether these other requirements are more or less stringent. The requirements in these Special Conditions must be satisfied in order for work to be funded with the State Revolving Fund.

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GENERAL REQUIREMENTS

These Special Conditions are based on guidance provided by the United States Environmental Protection Agency (EPA). Public Law 113-76, the Consolidated Appropriations Act, 2014 (Act), includes an "American Iron and Steel" (AIS) requirement that requires State Revolving Loan Fund (SRF) assistance recipients to use iron and steel products that are produced in the United States for projects in this project. A copy of Section 436 of the Act is found in Appendix 3.

The products and materials subject to these requirements will be defined in Appendix 1 of these special conditions.

The Owner must maintain documentation of compliance with the AIS requirements. The documentation that the Owner maintains will be subject to review and audit by representatives of the state of Georgia, the EPA, the EPA Office of the Inspector General, and other federal authorities.

The Prime Contractor must provide certifications of compliance for all products subject to AIS requirements to the Owner prior to requesting payments for those products. The Owner or the Engineer may require certifications of compliance with submittals and shop drawings for these products as part of the submittal review process.

All manufacturing processes for a covered iron or steel product, as further defined in Appendix 1, must take place in the United States. If a covered product is taken out of the US for any part of the manufacturing process, it becomes foreign source material.

The EPA recommends the use of a step certification process to document the locations of the manufacturing processes involved with the production of steel and iron materials. A step certification is a process under which each handler (supplier, fabricator, manufacturer, processor, etc.) of the iron and steel products certifies that its step in the process was domestically performed. Each time a step in the manufacturing process takes place, the manufacturer delivers its work along with a certification of its origin. A certification should include the name of the manufacturer, the location of the manufacturing facility where the product or process took place (not its headquarters), a description of the product or item being delivered, and a signature by a manufacturer's responsible party. Attached in Appendix 2 is a sample step certification.

Alternatively, the final manufacturer that delivers the iron or steel product to the worksite, vendor, or contractor, may provide a certification asserting that all manufacturing processes for the product and for its iron and steel components occurred in the United States. The EPA states that additional documentation may be needed if the certification lacks important information and recommends step certification as the best practice. A sample final manufacturer certification is attached in Appendix 2.

The Prime Contractor may document that incidental and generally low cost components, as defined in Appendix 1, are compliant with AIS requirements under the De Minimis Waiver issued by the EPA. For these items, the Contractor must provide the Owner with documentation of costs for these items, including invoices, and a report of types and categories of materials to which the waiver is applied, the total cost of incidental components covered by the waiver for each category, and the calculations by which the total cost of materials incorporated into the project was determined. A sample De Minimis report is attached is Appendix 2.

Contractor, supplier, and manufacturer records are subject to review and audit by the EPA, its Inspector General, and other federal authorities.

Failure to comply with these requirements may delay, limit, or prevent the disbursement of SRF funds to the Owner. Violations of AIS requirements will require correction by the Contractor as determined by the Owner and Engineer, including replacement of deficient products with compliant products and compensation for costs and other damages that may result. Violations may also subject the Owner, the Contractor, and suppliers to other enforcement actions within the discretion of the EPA and other federal authorities.

The Act permits EPA to issue waivers for a case or category of cases in which EPA finds (1) that applying these requirements would be inconsistent with the public interest; (2) iron and steel products are not produced in the US in sufficient and reasonably available quantities and of a satisfactory quality; or (3) inclusion of iron and steel products produced in the US will increase the cost of the overall project by more than 25 percent. The Contractor should notify the Owner and Engineer immediately if it finds that a waiver may be required.

By submitting a bid for this project and by executing this construction contract, the Contractor acknowledges to and for the benefit of the Owner and the state of Georgia that it understands that the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund or the Drinking Water State Revolving Fund and that Federal law authorizing these Funds contains provisions commonly known as "American Iron and Steel" that requires all of the iron and steel products used in the project to be produced in the United States ("American Iron and Steel Requirement") including iron and steel products provided by the Contactor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Owner and the state of Georgia that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Owner or the state of Georgia. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Owner or the state of Georgia to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney's fees) incurred by the Owner or the state of Georgia resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the state of Georgia or any damages owed to the state of Georgia by the Owner). The Owner and the Contractor agree that the state of Georgia, as a lender to the Owner for the funding of its project, is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the state of Georgia.

Appendix 1 – Definitions

For purposes of the Clean Water State Revolving Fund (CWSRF) and Drinking Water State Revolving Fund (DWSRF) projects that must comply with the AIS requirement, an iron or steel product is one of the following made primarily of iron or steel that is permanently incorporated into the project:

Lined or unlined pipes or fittings;
Manhole Covers;
Municipal Castings (defined in more detail below);
Hydrants;
Tanks;
Flanges;
Pipe clamps and restraints;
Valves;
Structural steel (defined in more detail below);
Reinforced precast concrete (defined in more detail below); and
Construction materials (defined in more detail below).

Product primarily of Iron or steel: The product must be made of greater than 50% iron or steel, measured by cost. If one of the listed products is not made primarily of iron or steel, United States (US) provenance is not required, except as required for reinforced precast concrete. If a product is composed of more than 50% iron or steel, but is not listed in Section 436 (a) (2) of the Act, it is not required to be produced in the US. Alternatively, the iron or steel in such a product can be sourced from outside the US.

Steel: An alloy that includes at least 50 percent iron and between 0.02 and 2 percent carbon and may include other elements. Other alloys of iron are not required to be produced in the US.

Produced in the United States: Production in the US of the iron or steel products used in the project requires that all manufacturing processes, including application of coatings, must take place in the United States, with the exception of metallurgical processes involving refinement of steel additives. All manufacturing processes includes processes such as melting, refining, forming, rolling, drawing, finishing, fabricating and coating. Further, if a domestic iron and steel product is taken out of the US for any part of the manufacturing process, it becomes foreign source material. However, raw materials such as iron ore, limestone and iron and steel scrap are not covered by the AIS requirement, and the material(s), if any, being applied as a coating are similarly not covered. Non-iron or steel components of an iron and steel product may come from non-US sources. For example, for products such as valves and hydrants, the individual non-iron and steel components do not have to be of domestic origin.

Municipal Castings: Municipal castings are cast iron or steel infrastructure products that are melted and cast. They typically provide access, protection, or housing for components incorporated into utility owned drinking water, storm water, wastewater, and surface infrastructure. They are typically made of grey or ductile iron, or steel. Examples of municipal castings include access hatches, ballast screen, benches, bollards, cast bases, cast iron hinged hatches, cast iron riser rings, catch basin inlets, cleanout/monument boxes, construction covers and frames, curb and corner guards, curb openings, detectable warning plates, downspout shoes, drainage grates, frames & curb inlets, inlets, junction boxes, lampposts, manhole covers, rings & frames, risers, meter boxes, steel hinged hatches, steel riser rings, trash receptacles, tree grates, tree guards, trench grates, and valve boxes.

Structural Steel: Structural steel is rolled flanged shapes, having at least one dimension of their cross-section 3 inches or greater, which are used in the construction of bridges, buildings, ships, railroad rolling stock, and for numerous other constructional purposes. Such shapes are designated as wide-flange shapes, standard I-beams, channels, angles, tees and zees. Other shapes include H-piles, sheet piling, tie plates, cross ties, and those for other special purposes.

Reinforced Precast Concrete: While reinforced precast concrete may not be at least 50% iron or steel, in this particular case, the reinforcing rebar must be produced in the US and meet the same standards as for any other iron or steel product. Additionally, the casting of the concrete product must take place in the US. The cement and other raw materials used in concrete production are not required to be of domestic origin. If the reinforced concrete is cast at the construction site, the reinforcing rebar is considered to be a construction material and must be produced in the US.

Construction Materials subject to AIS: Construction materials are those articles, materials, or supplies made primarily of iron and steel, that are permanently incorporated into the project, not including mechanical and/or electrical components, equipment and systems. Some of these products may overlap with what is also considered "structural steel". This includes, but is not limited to, the following products: welding rods, wire rod, bar, angles, concrete reinforcing bar, wire, wire cloth, wire rope and cables, tubing, framing, joists, trusses, fasteners (i.e., nuts and bolts), decking, grating, railings, stairs, access ramps, fire escapes, ladders, wall panels, dome structures, roofing, ductwork, surface drains, cable hanging systems, manhole steps, fencing and fence tubing, guardrails, doors, gates, and screens.

Construction Materials not subject to AIS: Mechanical and/or electrical components, equipment and systems are not considered construction materials. Mechanical equipment is typically that which has motorized parts and/or is powered by a motor. Electrical equipment is typically any machine powered by electricity and includes components that are part of the electrical distribution system.

The following examples, including their appurtenances necessary for their intended use and operation, are NOT considered construction materials: pumps, motors, gear reducers, drives, variable frequency drives (VFDs), mixers, blowers/aeration equipment, compressors, meters, electric/pneumatic/manual accessories used to operate valves (such as valve actuators), gates, motorized screens (such as traveling screens), sensors, controls, switches, supervisory control and data acquisition (SCADA), membrane bioreactor systems, membrane filtration systems, filters, clarifiers and clarifier mechanisms, rakes, grinders, disinfection systems, dewatering equipment, presses (including belt presses), conveyors, cranes, HVAC (excluding ductwork), water heaters, heat exchangers, generators, cabinetry and housings (such as electrical boxes/enclosures), lighting fixtures, electrical conduit, emergency life systems, metal office furniture, shelving, laboratory equipment, and analytical instrumentation.

Items temporarily used during construction, which are removed from the project site upon completion of the project, are not required to be made of U.S. Iron or Steel. For example, trench boxes or scaffolding are not considered construction materials subject to AIS requirements.

Incidental Components compliant with AIS under the De Minimis Waiver: This waiver permits the use of de minimis incidental components that may otherwise be prohibited under AIS. These de minimis items may cumulatively comprise no more than a total of 5 percent of the total cost of the materials used in and incorporated into the project. The cost of an individual item may not exceed 1 percent of the total cost of the materials used in and incorporated into the project.

These items are miscellaneous, generally low-cost components that are essential for, but incidental to, the construction and are permanently incorporated into the project. For many of these incidental components, the country of manufacture and the availability of alternatives are not always readily or reasonably identifiable prior to procurement in the normal course of business. For other incidental components, the country of manufacture may be known, but the miscellaneous character in conjunction with the low cost, individually and in total, as typically procured in bulk, mark them as properly incidental. Examples of incidental components include small washers, screws, fasteners (i.e., nuts and bolts), miscellaneous wire, corner bead, ancillary tube.

Examples of items that are not incidental and are not covered by the De Minimis Waiver include significant process fittings (i.e., tees, elbows, flanges, and brackets), distribution system fittings and valves, force main valves, pipes for sewer collection and/or water distribution, treatment and storage tanks, large structural support structures.

Items covered as compliant under this waiver must be documented in a report to the Owner to demonstrate that they are both incidental and that they fall within the cost allowances of this waiver. The costs of these items must be documented by invoices. The report must include a listing of types and categories of materials to which the waiver is applied, the total cost of incidental components covered by the Waiver for each category, and the calculations by which the total cost of materials incorporated into the project was determined.

Appendix 2 – Sample Certifications
Step Certification

The following information is provided as a sample letter of step certification for American Iron and Steel compliance. Documentation must be provided on company letterhead. This is to be provided by each handler (supplier, fabricator, manufacturer, processor, etc.). Each time a step in the manufacturing process takes place, the handler delivers its work along with a certification of its origin.

Date

Company Name
Company Address
City, State Zip

Subject: American Iron and Steel Step Certification for Project (Insert project name and SRF number)

I, (company representative), certify that the (melting, bending, coating, galvanizing, cutting, etc.) process for (manufacturing or fabricating) the following products and/or materials shipped or provided for the subject project is in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

List of items, products and/or materials:

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

Appendix 2 – Sample Certifications
Final manufacturer certification

The following information is provided as a sample letter of the final manufacturer to certify American Iron and Steel compliance for the entire manufacturing process. Documentation must be provided on company letterhead.

Date

Company Name
Company Address
City, State Zip

Subject: American Iron and Steel Certification for Project (Insert project name and SRF number)

I, (company representative), certify that the following products and/or materials shipped/provided to the subject project are in full compliance with the American Iron and Steel requirement of P.L. 113-76 and as mandated in EPA's State Revolving Fund Programs.

List of items, products and/or materials:

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

Appendix 2 – Sample Certifications
Contractor De Minimis Report

Owner: (Owner Name)
SRF Project No: (SRF Number)
Project Description: (Contract title or brief description)
Date: (Date of report)
Submitted by (name & title): (Contractor representative)
Company Name

LIST OF MATERIALS OR CATEGORIES OF MATERIALS PERMANENTLY INCORPORATED INTO THE PROJECT	**COST**	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Category or Item	$1,000.00	
Total Permanent Materials	**$10,000.00**	
1 % of total material cost	**$100.00**	**Maximum cost for individual item waived**
5 % of total material cost	**$500.00**	**Maximum cumulative cost for category waived**

LIST OF MATERIALS OR CATEGORIES OF MATERIALS COVERED BY DE MINIMIS WAIVER	**COST**	**COMPLIANT (Yes/No)**
Category or Item	$100.00	Yes
Category or Item	$100.00	Yes
Category or Item	$100.00	Yes
Category or Item	$100.00	Yes
Category or Item	$100.00	Yes
Total De Minimis Items	**$500.00**	Yes

INVOICES ATTACHED FOR DE MINIMIS ITEMS.

Appendix 3 – P.L. 113-76, Consolidated Appropriations Act, 2014

The Act states:

Sec. 436 (a)(1) None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j–12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.

(2) In this section, the term ''iron and steel products'' means the following products made primarily of iron or steel: lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and construction materials.

(b) Subsection (a) shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency (in this section referred to as the ''Administrator'') finds that—

(1) applying subsection (a) would be inconsistent with the public interest;

(2) iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or

(3) inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

(c) If the Administrator receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request and information available to the Administrator concerning the request, and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Web site of the Environmental Protection Agency.

(d) This section shall be applied in a manner consistent with United States obligations under international agreements.

(e) The Administrator may retain up to 0.25 percent of the funds appropriated in this Act for the Clean and Drinking Water State Revolving Funds for carrying out the provisions described in subsection (a)(1) for management and oversight of the requirements of this section.

(f) This section does not apply with respect to a project if a State agency approves the engineering plans and specifications for the project, in that agency's capacity to approve such plans and specifications prior to a project requesting bids, prior to the date of the enactment of this Act.

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 PROJECT INFORMATION

A. Project Name and Location/Address:
Shenandoah Wastewater Treatment Facility Improvements
1519 Poplar Rd
Newnan, GA 30265

B. Owner Information:
Coweta County Water & Sewerage Authority

C. Owner Contact:
545 Corinth Road
Newnan, GA 30263
770.254.3710

D. Engineer Information:
Krebs Engineering, Inc.
Jarred M. Jackson, P.E.
15 LaGrange Street
Newnan, GA 30263
470.724.5050
Jarred.Jackson@krebseng.com

E. Subconsultant Information :

1. MBA Engineers, Inc. (Structural)
Tripp Lindsey, P.E., S.E.
300 20th Street, North, Suite 100
Birmingham, AL 35203
205.323.6385
tlindsey@mbasei.com

2. Jackson, Renfro & Associates, Inc. (Electrical)
Phil Black, P.E.
141 Village Street, Suite #1
Birmingham, AL 35242
205.995.1078
phil@JRAee.com

3. Pinnacle Engineering, Inc. (Mechanical)
   Jeff Boyer, P.E.
   2111 Parkway Office Circle, Suite 125
   Birmingham, AL 35244
   205.733.6916
   jeffb@pinnacleegr.com

4. Architectrual Cooperative (Architect)
   Jared Bussey, AIA
   jaredb@architecturalcooperative.net
   2917 Central Avenue, Suite 101
   Birmingham, AL 35209
   205.533.3563

1.1 DESCRIPTION OF WORK INCLUDED IN THIS CONTRACT

The Work included in this Contract generally consists of improvements to the existing influent pump station, new headworks, new aeration blower/electrical building, new BNR aeration basin, improvements to the existing aeration basin (fine bubble diffusers, mixers, and BNR), new final clarifiers, new RAS/WAS pump station, additional (new) tertiary filters, new UV disinfection, new cascade (post) aeration, conversion of the existing final clarifiers to aerobic digesters, new solids handling facilities, chemical feed systems, miscellaneous yard piping, electrical, controls and SCADA improvements. This project is funded through GEFA; all pertinent federal requirements apply

The requirements of this Section and Division 1 apply to all of the Contract Documents.

1.2 OWNER PURCHASE CONTRACTS

A. The Owner has executed a purchase order(s) with suppliers of material and equipment to be incorporated into the Work. The purchase order(s) will be transferred to the Contractor and become part of this Contract. Contractor shall be responsible for coordinating the submittals, fabrication, and shipping/handling and delivery, and shall also be responsible for installation of the materials/equipment. The Contractor shall include all associated costs, including, but not limited to receiving, handling, storage if required, and installation/start-up of material and equipment, in the Contract Sum unless specifically stated otherwise in the Contract Documents.

B. The warranty and payment terms for the pre-selected equipment (BNR System, Solids Dewatering System, Biosolids Drying System, and UV Disinfection System) may change as a result of project delays, Contractor preference, or other reasons. Additionally, each manufacturer may have excluded certain items from their scope, and other labor, materials, and/or appurtenances may be required for a complete system. The Contractor is solely responsible for furnishing and installing all labor, materials, and appurtenances and for negotiating any additional changes to scope (e.g., additional warranty time) and/or cost with each pre-selected manufacturer in order to ensure that the Owner receives a complete, functional system that complies with all aspects of the Contract Documents. All additional costs and/or costs for items not included in manufacturers' scope of work shall be included in the base bid cost to construct the project.

C. Terms and Conditions for Pre-Purchased Equipment – The Contractor shall be responsible for contacting each supplier, reviewing all terms and conditions, and the schedule(s) with the supplier. The Contractor, if he/she deems it necessary, shall then negotiate and include all additional costs and/or adjustments to the Terms and Conditions as required to complete the Work. The Contractor shall be solely responsible for additional costs associated with changes to the Terms and Conditions.

D. Pre- purchased equipment is listed below:

1. Biological Nutrient Removal System. See Appendix "B" for copy purchase order and contract scope.

    a. Purchase Contract Firm and Representative:
        1) Xylem-Sanitaire
        2) Sean Sullivan (262) 327-7818, Sean.Sullivan@xylem.com
    b. Purchase Status: Order placed by the Owner to be transferred to the Contractor. Payment for the equipment will be made by the Contractor.

2. Solids Dewatering System: See Appendix "C" for copy purchase order and contract scope.
    a. Purchase Contract Firm and Representative:
        1) FKC Co, Ltd.
        2) Shane Harvey (360) 477-8038, sharvey@fkcscrewpress.com
    b. Purchase Status: Order placed by the Owner to be transferred to the Contractor. Payment for the equipment will be made by the Contractor.

3. Biosolids Drying System: See Appendix "D" for copy purchase order and contract scope.
    a. Purchase Contract Firm and Representative:
        1) BCR Environmental Corp.
        2) Keith Williams (512) 632-8158, KWilliams@bcrinc.com
    b. Purchase Status: Order placed by the Owner to be transferred to the Contractor. Payment for the equipment will be made by the Contractor.

4. UV Disinfection System: See Appendix "E" for copy purchase order and contract scope.
    a. Purchase Contract Firm and Representative:
        1) Trojan Technologies
        2) Farnaz Daynouri-Pancino (519) 636-3311, fdaynouri-pancino@trojantechnologies.com
    b. Purchase Status: Order placed by the Owner to be transferred to the Contractor. Payment for the equipment will be made by the Contractor.

1.3 PHASING AND SEQUENCE OF CONSTRUCTION

A. The Work shall be sequenced such that treatment processes are not interrupted. The WWTF must remain in compliance with the permitted discharge limitations, as identified in NPDES Permit No. GA0038822, at all times during the project. Bypass pumping will be required and temporary shutdowns of plant process must be coordinated and

scheduled with the Owner and Engineer. The Contractor shall submit a construction phasing plan prior to proceeding with the work.

1.4 WORK PERFORMED BY OWNER AND OTHER CONTRACTORS

A. SCADA system improvements shall be provided by the Owner's SCADA integrator.

B. Contractor shall fully cooperate and coordinate with Owner and other contractors to ensure that all work is completed in a smooth and orderly fashion without conflict, interference, or delay to work under this Contract or work done by Owner or other contractors.

1.5 ACCESS TO SITE

A. The Contractor shall have full use of the site unless otherwise stated in the Contract Documents. The Contractor shall limit work activities to areas within the limits of disturbance shown on the Drawings, and shall not disturb areas of the site that are beyond the Limits of Disturbance.

B. The Contractor shall maintain Owner use and access to buildings, driveways and other facilities at all times, unless specific exceptions are included in the Contract Documents.

C. The Contractor shall be solely responsible for protecting all existing and adjacent facilities from construction activities at all times, and shall be responsible for repairing any damage that results from construction of the Work.

1.6 COORDINATION WITH THE OWNER

A. Unless otherwise shown/stated specifically, the Owner will occupy the existing facilities during the construction period.

B. The Contractor shall minimize impacts from construction activities and shall not interfere with the Owner's operations unless and until 72 hours prior written notice has been provided to the Owner and written approval has been received from the Owner.

1.7 WORK HOURS AND OTHER RESTRICTIONS

A. The Contractor shall limit work hours as described in the General Conditions. On site work hours shall be between 7 a.m. and 6 p.m. unless prior written permission is obtained.

B. The Contractor shall take all necessary precautions/measures to limit noise, dust, odors and other disruptive impacts to the Owner and/or neighboring properties.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 22 00 - UNIT PRICES

PART 1 - GENERAL

1.1 UNIT PRICES

A. Unit prices are based on estimated quantities of items, but the Contractor shall be paid based on the actual measured quantity of each unit price item that is furnished and/or installed. Unit prices shall include all labor, delivery, materials, equipment, services, overhead, and profit attributable to each unit price item. Once the actual quantities are known, then a Change Order will be issued to incorporate the quantity increase or decrease into the Work.

B. Refer to individual Specification Sections for additional information.

C. The Contractor shall measure the unit price quantities furnished and/or installed, but the Owner shall have the right to verify the Contractor's measurements with Owner's forces and/or independently at Owner's expense.

D. List of Unit Price Bid Items: A schedule and description of the unit price bid items included in this Contract are provided below:

1. Unit Price Bid Item No. 10: Install 3,000 square yards of Asphalt Paving Section per the Contract Documents.
   a. Description: Furnish and Install Asphalt Paving Section per the Contract Documents. Unit price shall include all necessary labor, equipment, and material to provide new asphalt paving section at the locations as directed.
   b. Unit of Measurement: Per square yard of asphalt paving section installed.
2. Unit Price Bid Item No. 11: Install 9,600 square yards of Mill and Resurface Existing Asphalt Paving per the Contract Documents.
   a. Description: Furnish and Install Mill and Resurface Existing Asphalt Paving per the Contract Documents. Unit price shall include all necessary labor, equipment, material, and material disposal to mill and resurface existing asphalt paving at the locations as directed.
   b. Unit of Measurement: Per square yard of Mill and Resurface Existing Asphalt Paving installed.
3. Unit Price Bid Item No. 12: Install 1,600 square yards of Concrete Paving Section per the Contract Documents.
   a. Description: Furnish and Install Concrete Paving Section per the Contract Documents. Unit price shall include all necessary labor, equipment, and material to provide new concrete paving section at the locations as directed.
   b. Unit of Measurement: Per square yard of concrete paving section installed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 22 00

SECTION 01 23 00 – ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. The Owner reserves the right to select or reject alternates that are considered to be advantageous to the Owner.
B. No adjustments to the pricing for other components of the Work will be made.
C. No adjustments to the schedule or Contract completion dates will be made unless specifically identified for an alternate.
D. Only those alternates selected by the Owner and incorporated into the Contract Agreement are included in the Work.

1.2 SCHEDULE OF ALTERNATES

A. The alternates shown in the Proposal Form are listed and described below:

1. Alternate No. A1 – Alternate to Furnish and Install base bid equivalent Tertiary Disk Filters with one of the approved manufacturers – Five Star Filter Equipment or Beacon Water Technologies

a. The contractor will list an additive or deductive price to provide this model Tertiary Disk Filters in place of the Tertiary Disk Filters specified in Section 44 46 30 Disk Filters.

PART 2 - PART 2 - PRODUCTS (Not Used)

PART 3 - PART 3 – EXECUTION (Not Used)

END OF SECTION 01 23 00

SECTION 01 26 00 - CONTRACT MODIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for Contract modifications (Change Orders).

B. Change Orders must be in the form of a written document that changes the Contract scope, time, and/or Amount. Change Orders must be signed by the Contractor, Owner, and Engineer. Additional Change Order requirements can be found in the General Conditions.

C. The Engineer may issue instructions for minor changes in the Work without changes to the Contract Time and without changes to the Contract amount. The Engineer may provide job sketches or other additional information for these minor changes. The Contractor shall incorporate the minor changes into the Work in a timely manner.

D. The Contractor shall not stop work or execute the proposed change(s) unless and until a written Change Order has been executed.

1.2 CHANGE ORDER REQUESTS

A. If the Engineer or Owner requests a Change Order, then the Engineer will issue a description of proposed changes in the Work. The Engineer may also provide additional information in the form of drawings or specifications. The Contractor shall submit a proposed Change Order within 14 days of receipt of the Change Order request (unless otherwise specified).

B. Change Order proposals shall include the proposed changes to the Contract Amount and Contract Time. The Change Order proposal(s) shall be detailed, and shall include the following at a minimum:

1. Quantities for materials and equipment.
2. Units and unit costs.
3. Labor man-hours and unit costs.
4. Detailed list of equipment (and hours/days, unit cost for each).
5. Subcontractor costs (include quotes from subcontractors).
6. Vendor/supplier costs (include quotes from vendors/suppliers.
7. All applicable taxes and shipping/delivery.
8. Credits and/or offsets
9. Mark-up for Overhead and Profit (in accordance with requirements in General Conditions)
10. Updated construction schedule to reflect the change(s) and the impacts on start and finish times, critical path, and float. Additional Contract time will not be granted unless no float is available and critical path is impacted.
11. If Change Order request is initiated by the Contractor, then include a description of the reasons and justification for the request.

1.3 CHANGE ORDERS FOR ALLOWANCES AND UNIT PRICE WORK

A. Administrative change orders will be issued to incorporate the actual cost of allowances and/or to reflect the actual quantities of unit price items incorporated into the Work. Refer to those specification sections for procedures and requirements.

1.4 CONSTRUCTION CHANGE DIRECTIVE AND TIME AND EXPENSE CHANGE ORDERS

A. When there is not enough time for the Contractor to develop a Change Order proposal or when the Owner and Contractor disagree on the terms of a Change Order proposal, the Engineer may issue a written directive instructing the Contractor to proceed with changes in the Work. These changes will be performed on a time and expense basis and will be incorporated into the Contract at a later date with a written Change Order.

B. The Contractor is to promptly proceed with the changes in the work outlined in the Construction Change Directive. Should the Contractor disagree with the method provided for determining the proposed adjustments in the Contract Amount and/or Contract Time, he shall advise the Engineer of this disagreement. A Construction Change Directive signed by the Contractor indicates his agreement with the method for determining the proposed adjustments in the Contract Amount and/or Contract Time; however, the Contractor is to proceed with the work described in the Construction Change Directive regardless if the Contractor signs the Construction Change Directive or not.

C. The Contractor shall track and document the time and expense associated with the Work and shall maintain detailed records of the time and expense associated with the change(s).

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)
END OF SECTION 01 26 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. General coordination procedures.
   2. Requests for Information (RFIs).
   3. Project meetings.

1.4 GENERAL COORDINATION PROCEDURES

A. The Contractor shall coordinate construction operations with other contractors, the Owner, and other entities, to ensure the efficient and orderly installation of each part of the Work.

B. The Contractor shall prepare and coordinate the following administrative items with other contractors, the Owner, and the Engineer in order to ensure that the Work is completed in a smooth and orderly manner:

   1. Construction schedule.
   2. Schedule of values.
   3. Temporary facilities and controls.
   4. Submittals and coordination drawings.
   5. Progress meetings.
   6. Pre-installation meetings.
   7. Startup and commissioning
   8. Project closeout.

1.5 REQUESTS FOR INFORMATION (RFIs)

A. The Contractor shall prepare and submit an RFI immediately upon discovery of the need for interpretation or additional information.

B. The Engineer will review and respond to each RFI within seven (7) days of receipt of the RFI. The Engineer's review may include a request for additional information, in which case the Engineer will respond within seven (7) days of receipt of the requested additional information.

C. The Engineer will not review or respond to requests for approval of submittals, requests for approval of substitutions, requests for approval of Contractor's means and methods or incomplete RFI's.

D. The Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor with no response.

E. If the Contractor believes that an RFI response warrants a Change Order, then the Contractor shall notify the Engineer in writing within ten (10) days of receipt of the RFI response. Requests for Change Orders shall be handled in accordance with the requirements in the Contract Documents.

F. RFI Log: The Contractor shall prepare and maintain an RFI log, and shall update it monthly for review at the progress meetings. The Engineer may also prepare and maintain a separate RFI log.

G. The Contractor shall notify the Engineer within seven (7) days if he/she disagrees with the response. Otherwise, the Contractor shall immediately distribute RFI responses to subcontractors, vendors, and suppliers, as applicable.

1.6 PROJECT MEETINGS

A. Pre-Construction Meeting: The Engineer will schedule and conduct the pre-construction meeting, and will prepare and distribute meeting minutes.

1. Attendees: Attendees shall include the Contractor (project manager and superintendent, at a minimum), major subcontractors, the Owner, Engineer, and SRF representative (for SRF funded projects).
2. Agenda: The Engineer will prepare and distribute an agenda, which will include the following:

    a. Construction schedule and phasing (if applicable).
    b. Critical work sequencing and long-lead items.
    c. Substantial completion (if Contractor has questions regarding specific work items that are required to be complete before Owner accepts the project as being Substantially Complete.
    d. Key personnel and lines of communication.
    e. RFI procedures.
    f. Procedures for applications for payment.
    g. Submittal procedures.
    h. Use of the existing facilities and work restrictions/working hours.
    i. Temporary facilities and controls.
    j. Planned disruptions/shutdowns.
    k. Security.
    l. Progress cleaning.

B. Monthly Progress Meetings: The Contractor will schedule and conduct regular project progress meetings at the Project site unless otherwise indicated and will inform participants and others involved, and individuals whose presence is required, of the date and time of each meeting. The Contractor will coordinate the meeting dates and times with the Owner and Engineer. The Engineer will prepare and distribute meeting minutes.

1. Attendees shall include the Contractor (project manager and superintendent, at a minimum), major subcontractors, the Owner, and the Engineer.
2. Agenda: The agenda will typically include the following:
    a. Review and approve meeting minutes from the previous meeting.
    b. Review of construction progress.
    c. Review of upcoming/planned construction activities.
    d. Status of RFI’s and Change Orders.
    e. Status of Submittals
    f. Review of potential weather impacts or other scheduling impacts/delays.
    g. Other pertinent items.

C. Pre-installation and/or Pre-startup Meetings: Conduct pre-installation and/or pre-startup meetings before each major construction activity and/or startup of equipment and new facilities. Attendees shall include, at a minimum, the key Contractor personnel, key subcontractor personnel, the installer and/or manufacturer's representative, Owner and Engineer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the the Contractor's construction schedule.

1.3 INFORMATIONAL SUBMITTALS

A. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1.4 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate vendors and subcontractors.

B. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports. Secure time commitments for performing critical elements of the Work from entities involved. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
2. Submission and review of schedule by Engineer/Owner is for general compliance with Contract requirements and Contractor shall remain solely responsibel for developing and updating the schedule, identifying sequence of work, conflicts, work restrictions, phasing, all as required to meet the completion dates.

B. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work under More Than One Contract: Include a separate activity for each contract.
3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
4. Products Ordered in Advance: Include a separate activity for each product.
5. Owner-Furnished Products: Include a separate activity for each product
6. Work Restrictions: Show the effect of the following items on the schedule:

    a. Coordination with existing construction.
    b. Limitations of continued occupancies.
    c. Uninterruptible services.
    d. Partial occupancy before Substantial Completion.
    e. Use of premises restrictions.
    f. Provisions for future construction.
    g. Seasonal variations.
    h. Environmental control.

7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

    a. Subcontract awards.
    b. Submittals.
    c. Purchases.
    d. Mockups.
    e. Fabrication.
    f. Sample testing.
    g. Deliveries.
    h. Installation.
    i. Tests and inspections.
    j. Adjusting.
    k. Curing.
    l. Startup and placement into final use and operation.

8. Construction Areas: Identify each major area of construction for each 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:

    a. Structural completion.
    b. Permanent space enclosure.
    c. Completion of mechanical installation.
    d. Completion of electrical installation.
    e. Substantial Completion.

C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

D. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered RFIs.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.

E. Recovery Schedule: When periodic update indicates the Work is 30 or more calendar days behind the current approved schedule, submit a recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's construction schedule within 30 days of the Notice to Proceed.
B. Preparation: Indicate each significant construction activity separately.
C. Contract Modifications: For each proposed contract modification and concurrent with its submission, incorporate the effect of the proposed change on the overall project schedule.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Preconstruction photographs and video.
   2. Periodic construction photographs and video.

1.2 INFORMATIONAL SUBMITTALS

A. Digital Photographs and Video: Submit image files within 7 days of taking photographs/video.

B. Provide information on date and location of photos/videos.

1.3 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to Owner and Engineer for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 1600 by 1200 pixels and 400 dpi.

B. Digital Video Recordings: Provide high-resolution, digital video in a format acceptable to Engineer.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS AND VIDEO

A. Preconstruction Photographs: Prior to mobilizing and beginning Work, take photographs of the Project site and surrounding properties, including buildings and existing items to remain during construction, from different vantage points. Flag limits of disturbance prior to taking photographs. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

B. Periodic Construction Photographs: Take photographs monthly and as required to document construction progress.

C. Vantage Points: Coordinate with Engineer to select vantage points. During each of the following construction phases, take photographs from same vantage point each time to create a time-lapse sequence.

D. Date/Time Stamp: Include date/time stamp on photos and videos.

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUBMITTAL REVIEW AND COORDINATION

A. Submittal Development and Contractor Review: The contractor shall develop and submit submittals as required to allow adequate time for review without delaying/affecting the schedule for the Work. No Contract extension will be allowed for submittal development and/or review/resubmittal. The contractor shall thoroughly review and familiarize himself with the existing facilities and shall obtain/incorporate all necessary field dimensions into the submittals prior to submitting and prior to beginning Work.

B. The Contractor shall be solely responsible for coordinating preparation and review/processing of the submittals with manufacturers and suppliers and for ensuring that they are developed and approved as required to complete the Work on schedule.

C. Time for submittal review shall begin upon receipt of complete submittal by Engineer. The contractor shall allow a minimum of 14 days for submittal review when no concurrent consultant review (e.g. electrical review) is required. Where concurrent consultant submittal review is required, allow an additional 7 days (total of 21 days).

D. Resubmittal Review: Allow 14 days for review of each resubmittal.

E. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received. No extension of Contract time will be granted for this.

F. Engineer will maintain a submittal log throughout the project.

1.2 ENGINEER'S DIGITAL CAD FILES

A. Engineer's Digital Data Files: Electronic copies of CAD Drawings of the Contract Drawings will be provided by the Engineer for Contractor's use in preparing submittals.

B. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.

C. Digital Drawing Software Program: The Contract Drawings are available in Bentley Microstation (.dgn) or AutoCAD (.dwg) format.

D. Contractor shall execute a data licensing/use agreement provided by the Engineer.

PART 2 - PRODUCTS

2.1 GENERAL SUBMITTAL REQUIREMENTS AND PROCEDURES

A. Contractor shall prepare and submit submittals in accordance with requirements in each Specification Section.

B. Electronic submittals (pdf format) are acceptable and can be submitted via email or other means.

C. Action Submittals (Requiring Review and Comments): Submit five (5) paper copies. Engineer will return two (2) copies unless Contractor indicates that it is for informational purposes only.

D. Submittals shall include the following information:

1. Project name, Owner Name and Date.
2. Name of Engineering Firm and name/contact information for Engineer.
3. Name, Addresses, and Contact Information for Contractor, Subcontractor, Supplier, and Manufacturer
4. Submittal number or other unique identifier, including revision identifier. Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
5. Number and title of appropriate Specification Section.
6. Drawing number and detail references, as appropriate.
7. Location(s) where the product is to be installed, as appropriate.
8. Other necessary identification.

E. During the bid period and again prior to submitting/ordering and installing materials, products, and equipment, the Contractor and all manufacturers and suppliers shall thoroughly review the materials, products, and equipment being supplied and shall familiarize themselves with the existing and proposed/new facilities, as well as connections to existing facilities/utilities. This shall include field verification of the location, nature, size/dimensions, current and intended future use, etc. Prior to ordering and installation, the Contractor shall coordinate with all manufacturers and suppliers to provide all needed information including field dimensions, photographs, information on related materials and equipment, etc.). The Contractor and all manufacturers and suppliers shall confirm the following:

1. The materials, products, and equipment being supplied are of the correct size, materials, and type
2. The materials, products, and equipment being supplied do not conflict with existing or proposed/new facilities.
3. The products/equipment being supplied are intended for use in this application.

All manufacturer(s) and supplier(s) shall provide (either with submittals or separately) written concurrence/acknowledgment of their review/coordination and concurrence with the items above.

2.2 TYPES OF SUBMITTALS

A. Contractor's Construction Schedule: Prepare the construction schedule for review by the Engineer prior to the first progress meeting and prior to submitting an application for payment.

B. Schedule of Values – Prepare a schedule of values for review by the Engineer prior to submitting an application for payment.

C. List of Subcontractors and Major Equipment Suppliers: Prepare a written list of significant subcontractors and equipment suppliers to include name and contact information, and a brief description of work and/or equipment being provided.

D. Application for Payment

E. Product Data: Develop and submit information as a single submittal for each component of the Work. Product data shall include the following:

1. Indicate which options are available and which ones are being furnished.
2. Manufacturer's catalog cuts, product specifications, and color charts.
3. Statement of compliance with specified referenced standards.
4. Testing data.
5. Delivery/availability/schedule information.
6. Availability and delivery time information.
7. Wiring diagrams.
8. Performance curves.
9. Other relevant information.

F. Shop Drawings: Shop drawings shall be developed/drawn to scale and shall include the following:

1. Name/Number/Identification.
2. Drawings shall be in sufficient detail to determine size and configuration.
3. Dimensions in plan and section/elevation, where applicable.
4. Requirements for coordination.
5. Signed and sealed, if required, by a professional engineer.

G. Samples: Submit samples that are representative of the type, color, pattern, and texture to be furnished/installed. Samples shall include the following:

1. Name/Number/Identification/Description
2. Product name, manufacturer name, and source of sample.

3. Location to be installed (include reference to specification numbers and/or drawings).
4. Samples for related components shall be submitted as a single package.

H. Welding Certificates: Prepare and submit welding certificates to certify that welding personnel are qualified and that welding was performed in accordance with all applicable standards.

I. Product/Material Certificates and Test Reports: Submit written reports on supplier/manufacturer letterhead to certify that products/materials and/or test reports comply with the Contract Documents and all other applicable codes/standards.
Field Test Reports.

PART 3 – EXECUTION

3.1 CONTRACTOR'S REVIEW

A. The Contractor shall review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. The Contractor shall note corrections and field dimensions, and shall include an approval stamp before submitting to Engineer.

B. The Contractor’s approval stamp shall include the following:

1. Project name and location.
2. Submittal number and specification title/number.
3. Name of reviewer and date of Contractor approval.
4. Statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S REVIEW

A. Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. The Engineer will either stamp each submittal with an action stamp and will mark stamp appropriately to indicate action or will provide an electronic stamp including comments pertaining to the submittal. Each submittal will be marked with one of the items below:

1. No Exceptions Taken: The Engineer has no comments to provide the Contractor. The contractor may proceed with the current submittal acting as the final submittal.
2. Make Corrections: The Contractor shall include any corrections provided by the Engineer and shall proceed with the current submittal acting as final submittal.

3. Amend & Resubmit: The contractor shall make all necessary revisions as indicated by the Engineer and shall submit the corrected submittal to the Engineer for approval.
4. Rejected: Contractor shall resubmit based on the Engineer's comments.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer. Incomplete submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

D. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 01 33 00

SECTION 01410 – STRUCTURAL TESTS AND SPECIAL INSPECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements required for compliance with the International Building Code, Chapter 17, Structural Tests and Special Inspections.

B. Structural testing and special inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve contractor of responsibility for compliance with other construction document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the construction document requirements.
3. Requirements for contractor to provide quality-assurance and -control services required by architect, owner, or authorities having jurisdiction are not limited by provisions of this section.

C. The owner will engage one or more qualified special inspectors and / or testing agencies to conduct structural tests and special inspections specified in this section and related sections and as maybe specified in other divisions of these specifications.

D. Related Sections include but are not limited to the following:

1. 030000 CONCRETE.
2. 051200 STRUCTURAL STEEL.

1.3 DEFINITIONS

A. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the building official.

B. Construction Documents: Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the

elements of a project necessary for obtaining a building permit. Construction Documents include all supplemental instructions, sketches, addenda, and revisions to the drawings and specifications issued by the registered design professional beyond those issued for a building permit.

C. Shop Drawings / Submittal Data: Written, graphic and pictorial documents prepared and / or assembled by the contractor based on the Construction Documents.

D. Structural Observation: Visual observation of the structural system by a representative of the registered design professional's office for general conformance to the approved construction documents. Structural observations are not considered part of the structural tests and special inspections and do not replace inspections and testing by the testing agency or special inspector.

E. Special Inspector: A qualified person who demonstrating competence, to the satisfaction of the code enforcement official and registered design professional in responsible charge, for inspection of the particular type of construction or operation requiring special inspection. The special inspector shall be a licensed professional engineer or engineering intern or a qualified representative from the testing agency.

F. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

G. Special Inspection, Periodic: The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.

H. Testing Agency: A qualified materials testing laboratory under the responsible charge of a licensed professional engineer, approved by the code enforcement official and the registered design professional in responsible charge, to measure, examine, test, calibrate, or otherwise determine the characteristics or performance of construction materials and verify confirmation with construction documents.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications:
   1. Minimum qualifications of inspection and testing agencies and their personnel shall comply with ASTM E329-03 Standard Specification for Agencies in the Testing and / or Inspection of Materials Used in Construction.
      a. Inspectors and individuals performing tests shall be certified for the work being performed as outlined in the appendix of the ASTM E329. Certification by organizations other than those listed must be submitted to the building official for consideration before proceeding with work.
   2. In addition to these requirements, local jurisdiction may have additional requirements. It is the responsibility of the testing and inspection agencies to meet local requirements and comply with local procedures.

1.5 CONFLICTING REQUIREMENTS, REPORTS, AND TEST RESULTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the registered design professional in responsible charge for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the registered design profession in responsible charge for a decision before proceeding.

C. The special inspector's reports and testing agencies results shall have precedence over reports and test results provided by the contractor.

D. Where a conflict exists between the construction documents and approved shop drawings / submittal data, the construction documents shall govern unless the shop drawings / submittal data are more restrictive. All conflicts shall be brought to the attention of the registered design professional in responsible charge.

1.6 SUBMITTALS BY SPECIAL INSPECTOR AND / OR TESTING AGENCY

A. Special inspectors shall keep and distribute records of inspections. The special inspector shall furnish inspection reports to the building official, and to the registered design professional in responsible charge, contractor, architect, and owner. Reports shall indicate that work inspected was done in conformance to approved construction documents. Discrepancies shall be brought to the immediate attention of the contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the building official and to the registered design professional in responsible charge prior to the completion of that phase of the work. A final report documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted at a point in time agreed upon by the permit applicant and the building official prior to the start of work.

1. Special inspection reports and test results shall include, but not be limited to, the following:
    a. Date of inspection.
    b. Description of inspections or tests performed including location (reference grid lines, floors, elevations, etc.).
    c. Statement noting that the work, material, and / or product conforms or does not conform to the construction document requirements.
        1) Name and signature of contractor's representative who was notified of work, material, and / or products that do not meet the construction document requirements.
    d. Name and signature of special inspector and / or testing agency representative performing the work.

B. Schedule of Non-Compliant Work: Each agent shall maintain a log of work that does not meet the requirements of the construction documents. Include reference to original inspection / test report and subsequent dates of re-inspection / retesting.

C. Reports and tests shall be submitted within 1 week of inspection or test. Schedule of Non-Compliant Work shall be updated daily and submitted at monthly intervals.

D. Final Report of Special Inspections. Submitted by each agent listed in the schedule of Structural Testing and Special Inspections.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITY

A. The contractor shall coordinate the inspection and testing services with the progress of the work. The contractor shall provide sufficient notice to allow proper scheduling of all personnel. The contractor shall provide safe access for performing inspection and on site testing.

B. The contractor shall submit schedules to the owner, registered design professionals and testing and inspecting agencies. Schedules will note milestones and durations of time for materials requiring structural tests and special inspections.

C. The contractor shall repair and / or replace work that does not meet the requirements of the construction documents.
   1. Contractor shall engage an engineer / architect to prepare repair and / or replacement procedures.
   2. Engineer / architect shall be registered in the state in which the project is located. Engineer shall be acceptable to the registered design professional in responsible charge, code enforcement official, and owner.
   3. Procedures shall be submitted for review and acceptance by the registered design professional in responsible charge, code enforcement official, and owner before proceeding with corrective action.

D. The contractor shall be responsible for costs of:
   1. Re-testing and re-inspection of materials, work, and / or products that do not meet the requirements of the construction documents and shop drawings / submittal data.
   2. Review of proposed repair and / or replacement procedures by the registered design professional in responsible charge and the inspectors and testing agencies.
   3. Repair or replacement of work that does not meet the requirements of the construction documents.

3.2 STRUCTURAL OBSERVATIONS

A. Structural observations may be made periodically as determined by the registered design professional in responsible charge.

3.3 TESTING AND INSPECTION

A. Testing and inspection shall be in accordance with the attached Schedule of Special Inspections.

B. Reference related specifications for the minimum level of inspections and testing. Provide additional inspections and testing as necessary to determine compliance with the construction drawings.

PART 4 - SCHEDULES AND FORMS (ATTACHED)

4.1 STATEMENT OF SPECIAL INSPECTIONS.

4.2 SCHEDULE OF SPECIAL INSPECTIONS.

4.3 FINAL REPORT OF SPECIAL INSPECTIONS.

END OF SECTION 01410

STATEMENT OF SPECIAL INSPECTIONS

Project: Shenandoah WWTF
Project Address:
Permit Applicant:
Applicant Address:
Owner: Coweta County Water and Sewerage
Owner Address:

Registered Design Professionals (RDP):

Lead Engineer: Krebs Engineering
Geotechnical Engineer: Contour Engineering
Structural Engineer: MBA Engineers, Inc.
Mechanical Engineer:
Electrical Engineer:

This statement of special inspections is submitted as a condition for permit issuance in accordance with Chapter 17 of the International Building Code. It includes a *Schedule of Special Inspections* applicable to the above referenced project as well as the identity of the individuals, agencies, or firms intended to be retained for conducting these inspections.

The Special Inspector(s) shall keep records of all inspections and shall furnish interim inspection reports to the building official and to the registered design professional in responsible charge at a frequency agreed upon by the permit applicant and building official prior to the start of work. Discrepancies shall be brought to the immediate attention of the contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the building official and the registered design professional in responsible charge prior to completion of that phase of work. A *Final Report of Special Inspections* documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted by each agent at the completion of that phase of work.

Maximum frequency of interim report submittals shall not be less than one week.

The Special Inspection program does not relieve the contractor of the responsibility to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

Owner's Acknowledgement:

Signature Date

Building Official's Acceptance:

Signature Date

Permit No.

Frequency of interim report submittals to building official:

☐ Monthly ☐ Bi-Monthly ☐ Upon Completion ☐ Per Attached Schedule

RDP in Responsible Charge

MBA ENGINEERS, INC.
STRUCTURAL CIVIL GEOTECHNICAL

MBA ENGINEERS, INC.
STRUCTURAL CIVIL GEOTECHNICAL

Required Special Inspections

Project Name: Shenandoah WWTF
Project Address_____

During construction of the referenced project, it is intended that special inspection as outlined in Chapter 17 of the 2018 International Building Code be provided for by the owner. The following areas of work will require special inspection:

MATERIAL / ACTIVITY	FREQUENCY OF INSPECTION	INSPECTOR
A. Inspection of Steel per 1705.2 (in accordance with quality assurance inspection requirements of AISC 360).		
1. Inspection of welding:		
a. Prior to welding:		
1. Welding procedure specifications available	Continuous	Testing Agent
2. Manufacturer certifications for welding consumables available	Continuous	Testing Agent
3. Material identification (type/grade)	Periodic	Testing Agent
4. Welder identification system	Periodic	Testing Agent
5. Fit-up of groove welds (including joint geometry)	Periodic	Testing Agent
6. Configuration and finish of access holes	Periodic	Testing Agent
7. Fit-up of fillet welds	Periodic	Testing Agent
b. During welding:		
1. Use of qualified welders	Periodic	Testing Agent
2. Control and handling of welding consumables	Periodic	Testing Agent
3. No welding over cracked welds	Periodic	Testing Agent
4. Environmental conditions	Periodic	Testing Agent
5. Welding specification procedure followed	Periodic	Testing Agent
6. Welding Techniques	Periodic	Testing Agent
c. After welding:		
1. Welds cleaned	Periodic	Testing Agent
2. Size, length, and location of welds	Continuous	Testing Agent
3. Welds meet visual acceptance criteria	Continuous	Testing Agent
4. Arc strikes	Continuous	Testing Agent
5. K-area	Continuous	Testing Agent
6. Backing removed and weld tabs removed	Continuous	Testing Agent
7. Repair activities	Continuous	Testing Agent
8. Document acceptance or rejection of welded joint or member	Continuous	Testing Agent
2. Inspection of high-strength bolting:		
a. Prior to bolting:		
1. Manufacturer's certifications available	Continuous	Testing Agent
2. Fasteners marked in accordance with ASTM requirements	Periodic	Testing Agent
3. Proper fasteners selected for the joint detail	Periodic	Testing Agent
4. Proper bolting procedure for the joint detail	Periodic	Testing Agent
5. Connecting elements meet applicable requirements	Periodic	Testing Agent
6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used	Periodic	Testing Agent
7. Proper storage provided for bolts, nuts, washers, and other fastener components	Periodic	Testing Agent
b. During bolting:		
1. Fastener assemblies placed in all holes and washers (if required) are positioned as required	Periodic	Testing Agent

2. Joint brought to the snug-tight condition prior to the pretensioning operation	Periodic	Testing Agent
3. Fastener component not turned by the wrench prevented from rotating	Periodic	Testing Agent
4. Fasteners are pretensioned in accordance with the RCSC specification progressing systematically from the most rigid point toward the free edges	Periodic	Testing Agent
c. After bolting:		
1. Document acceptance of rejection of bolted connections	Continuous	Testing Agent
MATERIAL / ACTIVITY	**FREQUENCY OF INSPECTION**	**INSPECTOR**
B. Inspection of Concrete per 1705.3 – 1705.3.1 & Table 1705.3		
1. Inspection of reinforcing steel and placement.	Periodic	Testing Agent
2. Inspection of anchors cast in concrete where allowable loads have been increased, or where strength design has been used.	Periodic	Testing Agent
3. Inspection of anchors post-installed in hardened concrete members.	Periodic	Testing Agent
4. Verifying use of required design mix.	Periodic	Testing Agent
5. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	Continuous	Testing Agent
6. Inspection of concrete and shotcrete placement for proper application techniques.	Continuous	Testing Agent
7. Inspection for maintenance of specified curing temperature and techniques.	Periodic	Testing Agent
8. Inspect formwork for shape, location, and dimensions of the concrete member being formed.	Periodic	Testing Agent
C. Inspection of Soil Conditions per 1705.6		
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	Periodic	Testing Agent
2. Verify excavations are extended to proper depth and have reached proper material.	Periodic	Testing Agent
3. Perform classification and testing of compacted fill materials.	Periodic	Testing Agent
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill.	Continuous	Testing Agent
5. Prior to placement of compacted fill, observe subgrade and verify that site has been prepared properly.	Periodic	Testing Agent

FINAL REPORT OF SPECIAL INSPECTIONS

Project: Shenandoah WWTF

Project Address:

Testing / Inspection Agent:

Testing / Inspection Agent Address:

Scope of Testing / Inspections:

To the best of my information, knowledge, and belief, the special inspections or testing required for this project, and designated for this Agent in the *Schedule of Special Inspections* submitted for permit, have been completed in accordance with the contract documents.

Interim reports submitted prior to this final report and numbered to - , form a basis for, and are to be considered an integral part of this final report.

Special Inspector's Seal

Prepared By:

Type or print name

Signature Date

(Licensed Professional Engineer)

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for temporary utilities, temporary support facilities, and temporary security.

1.2 USE CHARGES

A. The Contractor shall include all transfer and use charges and associated costs for temporary facilities (including setup, installation, and removal) and permanent facilities in the Contract unless specifically indicated otherwise.

B. Temporary Water and Sewer Service from Existing System: Water from the Owner's existing water system is available for temporary use without metering and without payment of use charges until the (Final) Contract Completion date. Provide connections and extensions of services as required for construction operations.

C. Temporary Electric Power Service from Existing System: Electric power from the Owner's existing system is available for temporary use without metering and without payment of use charges until the (Final) Contract Completion date. Provide connections and extensions of services as required for construction operations.

D. Initiate and schedule the transfer of temporary utility service to the Owner upon project completion. Costs associated with establishing all utility services in the Owner’s name shall be borne by the Contractor.

1.5 QUALITY ASSURANCE

A. For all electric power service, the Contractor shall comply with all applicable codes (NECA, NEMA, and UL standards and regulations, and NFPA).

B. Contractor shall obtain the required permits for all utilities.

C. Contractor shall comply with all applicable OSHA and ADA provisions for temporary ingress/egress.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chain-Link Fencing: Temporary chain-link fencing shall be equivalent to existing fencing, or if no existing fencing, then temporary fencing shall be minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch- OD corner and pull posts, and 1-5/8-inch-OD top rails.

B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum

2-3/8-inch-OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails. Provide concrete or galvanized-steel bases for supporting posts.

C. Wood Enclosure Fence: Plywood, 8 feet high, framed with four 2-by-4-inch rails, with preservative-treated wood posts spaced not more than 8 feet apart.

D. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with a flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2

2.2 TEMPORARY FACILITIES

A. Field Offices: Field offices shall be prefabricated or mobile units with temperature controls, foundations, and utilities.

B. Engineer's Field Office: Engineer's separate field office shall include the following:

1. Minimum dimensions of 12 feet wide by 40 feet long.
2. One (1) plantable and one (1) plan rack with not less than five (5) plan holders.
3. One (1) four drawer letter size file cabinet.
4. One (1) desk and desk chair.
5. Two (2) side chairs.
6. One (1) closet for storage of work gear, instruments and equipment.
7. One (1) separate room with toilet and lavatory providing hot and cold running water.
8. Two (2) sets of keys to all lockable doors.
9. Minimum of four (4) duplex electrical outlets.
10. Adequate lighting for office work.
11. Two (2) waste receptacles.
12. One (1) telephone service receptacle.
13. Installation and use charges for electrical power, natural gas (if required), potable water, and wastewater (if applicable).
14. Installation and use charges for telephone service.
15. Garbage (waste) disposal services and daily office clean-up services; and provision of soap, toilet paper, and paper towels, as needed.
16. Internet Access: Highspeed (DSL, cable modem, or wireless "hot spot") internet, unlimited access.
17. Printer: HP Officejet 4630 e-All-In-One Printer, Scanner, Copier and Fax, or recent equivalent.
18. APC Back-UPS 550 - Surge Protection and Battery Back-UP

C. Contractor shall furnish and maintain fire extinguishers with appropriate location, class, and extinguishing agent(s) for recommended exposures (in accordance with NFPA and other applicable codes).

D. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

E. Heating Equipment: Unless the Owner authorizes the use of a permanent heating system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.

2. Heating Units: Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, and marked for the intended use for the type of fuel being consumed.

F. Air Conditioning Unit: Provide air condition units as necessary to ensure a cool operating environment.

G. Electrical Outlets: Properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.

H. Power Distribution System Circuits: Where permitted and overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.

PART 2 - EXECUTION

3.1 GENERAL

A. Coordinate with the Owner to locate the temporary facilities.

B. Isolate and protect Work areas and/or occupied facilities to prevent dust and fume entry.

C. Temporary Use of Facilities and Equipment: Any facilities or equipment that are used by the Contractor during construction shall be made to be in “like new” condition with full manufacturer’s warranty prior to being turned over to the Owner. Items not meeting this requirement to the satisfaction of the Owner shall be deemed to be “used” and shall be replaced at the Contractor’s expense.

D. Provide temporary fire protection as necessary to protect against fire losses during construction.

E. Make provisions to protect materials and facilities from water damage and potential for creating mold, and keep interior spaces clean and dry. Control moisture and humidity if necessary.

F. Do not remove temporary facilities until they are no longer needed.

3.2 INSTALLATION OF TEMPORARY UTILITIES

A. Contractor is responsible for coordinating with Owner and/or utility providers for temporary utility installation.

B. Contractor shall provide temporary toilets, wash stations, and potable water for use of construction personnel.

C. Contractor shall provide temporary heating/cooling/dehumidification when required by construction activities for curing, drying, protection or for other reasons.

D. Provide temporary lighting as needed for construction operations, inspections and security.

3.3 INSTALLATION OF TEMPORARY OFFICES AND SITE IMPROVEMENTS

A. Temporary offices, shops, and sheds shall be located within the construction area and away from existing and new buildings. Comply with all applicable codes for location and construction of temporary facilities.

B. Construct and maintain temporary roads and parking as needed for construction operations and as needed for the Owner's operations.

C. Protect existing site improvements to remain including curbs, pavement, and utilities.

D. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Contractor is solely responsible for establishing and maintaining temporary dewatering facilities and shall discharge all water in a lawful manner without affecting the facilities or adjacent properties. The contractor is solely responsible for any damage that occurs due to dewatering activities, failure to implement dewatering facilities or insufficient dewatering activities.

F. Furnish and install temporary project signs.

G. Protect the existing site and facilities to include vegetation, structures, and utilities, and shall comply with environmental regulations at all times.

H. Furnish and install all necessary temporary sediment and erosion control measures to prevent soil erosion and discharge of sediment-laden water runoff and airborne dust.

I. Protect existing trees and vegetation from construction operations.

J. For sites that have an existing perimeter fence, erect and/or maintain a temporary fence unless specifically noted otherwise.

K. Provide signs, barricades, and lights as required by local authorities and/or code.

L. Restore, repair and clean the site to include removal of temporary gravel and pavement, soils that are unsuitable for landscaping or grassing, and repairing/replacing paving, curbs and sidewalks.

M. Restore, repair and clean permanent facilities at Substantial Completion. Clean facilities again at Final Completion where necessary.

END OF SECTION 01 50 00

SECTION 01 73 00 – EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general administrative and procedural requirements governing the execution of the Work including, but not limited to, the following:

1. Existing Conditions
2. Preparation and Construction layout.
3. Installation of the Work.
4. Cutting and patching.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.
8. Correction of the Work.

1.2 SUBMITTALS

A. Final Survey: Submit final property and/or topographic/planimetric site survey performed by a licensed professional land surveyor. The Final Survey shall include all significant features, boundaries, benchmarks, contours, utility locations (valves, manholes, meters, etc.), and new piping inverts (stormwater and sanitary sewer). The survey shall also include approximate limits of partially demolished/abandoned structures below grade.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: All materials used for cutting and patching shall be identical to in place materials. When identical materials are not available, new materials shall match existing (visually/aesthetically) as closely as possible, and shall be as durable in nature and as functional as existing materials.

PART 3 - EXECUTION

3.1 EXISTING CONDITION

A. The Contractor shall visit the site prior to bidding the Work and shall become familiar with the existing facilities, including sizes, locations, materials, and other features of existing utilities/facilities. Prior to beginning work, the Contractor shall verify the location, sizes, and other features of existing utilities at connection points, crossing locations and/or other key locations. The existence and location of underground and other utilities and construction indicated as existing are not guaranteed, so the Contractor shall fully investigate the existence, size, location, and features (e.g.

materials) as required to accurately price the Work prior to bidding the Work, and as required to execute the Work prior to orderings/installation.

B. Prior to bidding the Work, and prior to ordering materials and beginning Work, the Contractor shall examine all existing conditions (utilities, structures, finishes, etc.) and verify compatibility and suitability of materials, equipment, and systems for all Work. Include all relevant information (including potential conflicts and/or issues such as compatibility, sizing) in a submittal(s) for review by the Engineer. Proceed with ordering and installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION AND CONSTRUCTION LAYOUT

A. The Contractor shall coordinate with the Owner and/or local utilities regarding the need to relocate existing utilities.

B. The Contractor shall be solely responsible for taking field measurements required to complete the Work and shall incorporate the field measurements into submittals for review by Engineer prior to ordering materials and equipment and prior to beginning Work.

C. The Contractor shall verify that no conflicts exist prior to ordering materials and equipment and prior to beginning Work. If conflicts and/or different field conditions are discovered, then the Contractor shall notify the Engineer immediately.

D. Construction Layout: The Contractor shall engage a land surveyor to verify and/or establish benchmarks, verify layout information shown on the Drawings, and layout the Work. The Contractor shall check the location and correctness of the Work as it progresses.

3.3 INSTALLATION

A. The Contractor shall always confirm with the manufacturer and shall follow the manufacturer's written instructions and recommendations for installing products.

B. Bracing and Supports: The Contractor shall furnish and install all necessary anchors, fasteners, braces, and supports required to securely anchor/support the Work. If size, quantity and/or type of anchor/support/brace is not shown, verify with manufacturer(s).

C. All components of the Work shall be installed plumb, straight, and level, and to maximize clearance(s) for access and/or maintenance. The Contractor shall also make provisions for thermal expansion and contraction.

3.4 CUTTING AND PATCHING

A. The Contractor shall employ skilled and experienced workers and shall do the following with respect to cutting and patching:

1. Patch the Work as quickly as possible after cutting.
2. Restore surfaces/cuts to their original condition or better.
3. Provide temporary bracing and supports.
4. Protect adjacent areas and/or other new construction.
5. Minimize interruption of existing utilities/facilities and coordinate with Owner prior to cutting/patching.
6. Patch in a manner that minimizes evidence of the Work.
7. Clean affected areas after cutting and patching is complete.

3.5 PROGRESS CLEANING

A. The Contractor shall maintain a clean project site and shall clean daily.

B. The Contractor shall not hold/accumulate waste(s) and shall dispose of waste in accordance with all applicable regulations/requirements. Waste materials shall not be buried or burned on site.

C. The Contractor shall clean and protect installed Work.

3.6 STARTING AND ADJUSTING

A. The Contractor shall coordinate startup and testing of equipment with the manufacturer, subcontractors, Engineer, and the Owner.

B. The Contractor shall obtain manufacturer concurrence/approval of installation prior to startup. Malfunctioning/defective materials and equipment shall be replaced with new materials and equipment at no cost to the Owner.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. The Contractor shall protect and maintain the Work in new condition (without damage or degradation) until Final Completion. This includes maintaining cleanliness and avoiding staining of concrete walls and slabs due to construction activities. The Contractor shall be solely responsible for maintaining and/or cleaning to achieve a new finish, even if it requires resurfacing/recoating and/or replacing the affected Work.

3.8 CORRECTION OF THE WORK

A. The Contractor shall repair or remove and replace defective equipment, materials and/or construction at no cost to the Owner. All Work shall be restored and/or maintained in new condition until Final Completion.

END OF SECTION 01 73 00

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. The following requirements must be met/completed before closing out the project:

1. Substantial Completion: The Contractor must have achieved written Substantial Completion in accordance with the requirements in the General Conditions.
2. Prepare and submit Project Record Documents.
3. Prepare and submit Operation and Maintenance Manuals.
4. Deliver tools, spare parts, extra materials, salvaged materials, etc. to Owner.
5. Completion of all equipment start-up and training.
6. Develop the punch list and complete all punch list items.
7. Warranties: Obtain and submit specific equipment and product warranties. Overall project warranty and individual equipment/system warranties shall begin upon approval (date of Owner signature) of the Final Payment Application unless specifically stated otherwise.
8. The Contractor must satisfactorily address outstanding warranty items before Final Payment will be made.
9. Obtain and submit release permitting Owner unrestricted use of the Work and include occupancy permits/certificates, where applicable.
10. Removal of temporary facilities from the Project site.
11. Notify Owner of insurance changeover/transfer requirements, where applicable.
12. Place any permanent utilities in the Owner's name.
13. Final Cleaning: Employ experienced and skilled workers or a professional cleaning service. Cleaning shall include the project site, grounds, buildings, and all other facilities and areas affected by the construction. HVAC systems (including ducts) shall be inspected and cleaned and filters replaced.
14. Advertise for completion in accordance with the requirements in the General Conditions.
15. Written Consent of Surety: The Contractor shall have submitted written consent of Surety Company to final payment;
16. Affidavits: The Contractor shall have submitted affidavits (see General Conditions) and satisfactory evidence that there are no outstanding claims or demands against the Contractor in any manner connected with the work.
17. Submit a Final Application for Payment.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 77 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for Operation and Maintenance manuals.
B. Additional information on Operation and Maintenance manual content may be included in the individual specification sections for equipment and systems.

1.2 SUBMITTALS

A. Submit three (3) initial hard copies and one digital (pdf) copy of Operation and Maintenance Manuals prior to training and prior to Substantial Completion.
B. Engineer/Owner will review initial submittals and provide comments. Incorporate comments and resubmit three (3) Final hard copies and one final digital searchable pdf copy.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR OPERATION AND MAINTENANCE MANUALS

A. Operation and Maintenance manuals shall be organized into separate sections for each system, and each manual shall include the following:

1. Title page with name and address of Project, name and address of Owner, Contractor, Engineer.
2. Date of Submittal
3. Table of contents.
4. Manual contents.

B. Hard copies shall be bound in heavy duty, three-ring binders (8-1/2x11 inch). Each binder shall be labeled on the cover and on the spine, and sections shall be tabbed.

2.4 OPERATION AND MAINTENANCE MANUALS

A. Generally, Operation Manual content shall include the following:

1. Product name, model number, and description of systems and equipment.
2. Serial numbers.
3. Drawings and diagrams/identification of parts and components.
4. Design and performance criteria and curves.
5. Operating standards and procedures.
6. Wiring and control diagrams and description of controls.
7. Precautions against improper use.
8. Maintenance, cleaning, and inspection requirements and procedures.
9. Engineering data and tests.
10. Startup procedures.
11. Routine and normal operating procedures.
12. Normal shutdown instructions.
13. Warranties/Bonds.

14. Troubleshooting Guide(s).
15. Other pertinent data and/or instructions.

PART 3 – EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Manuals shall be prepared by the manufacturer(s).

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the requirements for the following:

1. Record Drawings.
2. Record Specifications and Product Data.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Maintain one set of marked-up hard copies of the Contract Drawings and Shop Drawings. Mark-ups should show where the actual installation was different than what was shown on Construction Drawings. Note related field directives, change orders, or modifications, and include/attach photos if needed. Submit the Record Drawings to the Engineer at Substantial Completion.

2.2 RECORD SPECIFICATIONS AND PRODUCT DATA

A. Maintain one set of mark-up hard copies of the Contract Specifications and any miscellaneous product data to indicate where the actual installation was different than what was shown in the Construction Specifications. Note related field directives, change orders, or modifications, and include/attach photos if needed. Submit the Record Specifications and Product Data to the Engineer at Substantial Completion.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 39

SECTION 02 41 19 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items to be reused or recycled.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. The Contractor shall remove all equipment, pumps, piping, etc. so that it can be reused by the Owner.

B. Unless otherwise indicated, demolition waste becomes property of Contractor. All scrap metals shall be stored for the Owner's salvage in an area to be determined by the Owner.

C. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

D. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
   1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
   2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
   3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
   4. Cover and protect furniture, furnishings, and equipment that have not been removed.
   5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 01 Section "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
   1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. All metals shall be stored on site for the Owner's use. The Owner will provide containers for separating metals.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

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 cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
   1. Footings.
   2. Foundation walls.
   3. Slabs-on-grade.
   4. Suspended slabs.
   5. Concrete toppings.
   6. Building frame members.
   7. Building walls.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, “Details and Detailing of Concrete Reinforcement.” Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

D. Formwork: Submit the type of system(s) to be used. Design and engineering of formwork are the Contractor’s responsibility.

E. Welding certificates: Copies of welding procedures and personnel.

F. Material Certificates for cementious materials, aggregates and waterstops; signed by manufacturers certifying compliance with requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

E. ACI Publications: Comply with ACI 301 (Specifications for Structural Concrete) and ACI 117 (Specifications for Tolerances for Concrete Construction and Materials), unless more stringent provisions are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Cement: Store in dry, weather-tight, well ventilated storage shed or storage bin.

C. Aggregate: Store to protect against contamination from surface runoff, trash, debris, dirt, site materials, oils, grease, etc. Store coarse aggregate to prevent segregation, and store fine aggregate in bins or compartments.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. PVC Waterstops:

a. Greenstreak
b. Approved Equivalent

2. Self-Expanding Strip Waterstops:

a. Superstop; Progress Unlimited Inc.
b. Sika-swell
c. Approved Equivalent

3. Joint Filler Material:

a. Sika Chemical Corp.
b. Grace Construction Products Co.
c. W.R. Meadows, Inc.
d. Approved Equivalent

4. Cement Based Sealers:

a. Thoro Concrete Products (ChemRex)
b. Approved Equivalent

5. Grout

a. General Construction

i. Bonsal/ProSpec F-77
ii. Approved equivalent

b. Machinery, Non-Shrink

i. Sika 212
ii. Approved equivalent

c. Epoxy

i. Fivestar HP
ii. Approved equivalent

d. Rock Anchor Bolt
i. Euco Rock Anchor Bolt Grout
ii. Approved equivalent

e. Clarifier Grout
i. 3000 psi, 25% ash, 0.45 w/c ratio, fine aggregate, 1% air mix.

2.2 VAPOR RETARDERS

A. Vapor Retarder: ASTM E 1745, Class C, of one of the following materials; or polyethylene sheet, ASTM D 4397, not less than 10 mils thick:

B.

1. Nonwoven, polyester-reinforced, polyethylene coated sheet; 10 mils thick.
2. Three-ply, nylon- or polyester-cord-reinforced, laminated, high-density polyethylene sheet; 7.8 mils thick.

2.3 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.
   2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1.

B. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation. Maintain true radii so that no irregularities or breakpoints around the circumferences of the circles will be visible.

C. Chamfer Strips: Wood, Metal, PVC, or rubber strips, ¾ by ¾ inch, minimum.

D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, will not leave holes through the concrete surface.
   3. Furnish ties with integral water-barrier plates.

2.4 STEEL REINFORCEMENT

A. Fabricating Reinforcement: Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.5 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

B. Joint Dowel Bars: Plain round stick steel bars, ASTM 675, Grade 80. Bars used in expansion joints shall be ¾" x 24" long fitted with end caps. Cut bars true length with ends square and free of burs.

2.6 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   1. Profile: Flat, dumbbell with center bulb for expansion joints, 9" width and ¾" thickness, min.
   2. Profile: Ribbed with center bulb for construction joints, 6" width and ¾" thickness, min.

B. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophylic material for adhesive bonding to concrete.

2.7 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials:[Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.] Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 25 percent.
   2. Combined Fly Ash and Pozzolan: 25 percent.
   3. Ground Granulated Blast-Furnace Slag: 50 percent.
   4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
   5. Silica Fume: 10 percent.
   6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to **0.15** percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.8 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I, Type II, or Type V

1. Fly Ash: ASTM C 618, Class F.

B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, intended for moderate weathering region, but not less than Class 3M, and as follows:

1. Fine Aggregate: Clean, hard, durable, uncoated particles of natural silica or acceptable alluvial sand with the following gradation requirements:
2.

a.	Passing 3/8" Standard Sieve	100 %
b.	Passing #4 Standard Sieve	95 - 100 %
c.	Passing #8 Standard Sieve	80 - 100 %
d.	Passing #16 Standard Sieve	50 - 85 %
e.	Passing #30 Standard Sieve	25 - 60 %
f.	Passing #50 Standard Sieve	10 - 30 %
g.	Passing #100 Standard Sieve	2 - 10 %

h.

3. Coarse Aggregate with the following gradation requirements:
4.

a.	Passing 1 ½” Standard Square Sieve	100 %
b.	Passing 1" Standard Square Sieve	95 - 100 %
c.	Passing ½” Standard Square Sieve	25 - 60 %
d.	Passing #4 Standard Square Sieve	0 - 10 %
e.	Passing #8 Standard Square Sieve	0 - 5 %

f.

5. Water: Potable and complying with ASTM C 94.

2.9 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.

C. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

D. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

E. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.10 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Membrane Curing Compounds: Conform to ASTM C 309 and shall have a minimum of 18% solids, be non-yellowing, and have a unit moisture loss of less than 0.039 gm/cm^2 at 72 hours. Rate of application of curing compounds should follow manufacturer's recommendations or be in the range of 150 to 200 ft^2/gal.

1. Curing compounds for use in water treatment facilities shall be nontoxic, free of taste and odor, and NSF approved.
2. Curing compounds must be suitable for specific applications such as underneath floor treatments, etc.

2.11 RELATED MATERIALS

A. Joint Filler Material: Isolation/Expansion Joints

1. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber for non-water bearing applications.
2. Joint-Filler Strips: ASTM D 1752, Type 1, elastic sponge rubber for water bearing applications
3. Backer Rod: Premium grade polyethylene foam or Rescor type filler material.
4. Joint Primer: Recommended by manufacturer of the joint sealant, similar and equivalent to Sikaflex Primer 429.

5. Joint Sealer: Provide non-sag elastomeric, moisture cured sealant (one component, polyurethane base)

B. Bonding Agents: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

D. Reglets: Fabricate reglets of not less than 0.0217-inch-thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

E. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

F. Cement Based Sealers: Portland cement based coatings to fill and seal concrete pores and voids; to correct surface irregularities; capable of being overcoated with decorative finish

G. Water Based High Build Acrylic Coatings: Refer to Division 9 Section “High Performance Coatings”

H. Reinforced Structural Concrete: Proportion concrete mix as follows:

1. Compressive Strength (28 Days): 3000 psi, 4000 psi and 5000 psi.
2. Slump: 3 to 5 inches
3. Maximum Slump for Concrete Containing High-Range Water-Reducing Admixture is 8 inches after admixture is added to concrete that had an initial slump of 3 to 5 inches.
4. Maximum W/C (water-to-cementious materials) ratio = 0.45 (0.50 for 3000 psi)

I. Unreinforced Concrete: Proportion concrete mix as follows:

1. Compressive Strength (28 Days): 3,000 psi.
2. Maximum Slump: 3 to 5 inches

J. Reinforced Masonry Walls:

1. Compressive Strength (28 Days): 3,000 psi.
2. Maximum Slump: 8 inches.
3. Coarse Aggregate: Pea Gravel no greater than ½ inch.

K. Grout

1. Grout to be used for various purposes and in various locations on the project shall be as specified below.
2. Place grout with a cement/sand ratio of 1:2 in forms for starting pours or lifts of concrete.

3. General Construction grout shall be non-shrink, expanding type, and shall have the following characteristics: non-ferrous; non-staining; non-bleeding; high density; and not containing gas-generating agents. The compressive strength at 28 days of grout mix of 50 pounds with 5-3/4 quarts of water shall not be less than 4500 psi (per ASTM C109). The mix shall retain high compressive strength when containing coarse aggregate crushed stone in size range ¼" – 3/8". General construction grout shall be used for closing in box-outs, filing holes in concrete, patching walls, etc.
4. Machinery grout shall be non-shrink type, and shall have the following characteristics: high flow at low water content; non-staining; non-bleeding; non-metallic; high density; and not containing gas-generating agents. The compressive strength at 28 days of grout mix of 50 pounds with 3-3/4 quarts of water shall not be less than 7500 psi (per ASTM C109). The grout mix shall meet the requirements of Corps of Engineers Specification CRD C-621 and ASTM C-1107. Machinery grout shall be used for structural bearing plates, anchor bolts, machinery and equipment.
5. Epoxy grout shall be a non-shrink, 100% solids grout containing thermosetting epoxy resins, expansive additives and inert fillers. Compressive strength at 7 days shall be 16,000 psi. Tensile strength and flexural strength shall be 2000 psi and 4400 psi, respectively. Epoxy grout shall be used where indicated.
6. Rock anchor bolt grout shall be non-shrink, pumpable, portland cement-based with high early strength and low permeability. Compressive strength at 24 hours shall be 4000 psi, unless specifically noted otherwise.
7. All prepared grout mixes shall be used in strict accordance with the manufacturer's recommendations. Compressive strength testing of grout cubes may be required if requested by the Engineer.

PART 3 - EXECUTION

3.1 VAPOR RETARDERS

A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.

3.2 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual to ¼".

D. Construct forms tight enough to prevent loss of concrete mortar or water.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.

1. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Block or bulkhead openings for pipe to prevent entrance of water.

K. Form openings for gates even and true both horizontally and vertically so that gates can be installed watertight.

L. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

M. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

N. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.3 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
1. Install anchor bolts, accurately located, to elevation required.
2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashing in outer face of concrete frame at exterior walls, where flashing is shown at linlets, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Do not heat, straighten, or re-bend reinforcing steel in a manner that will injure the material.

C. Roll bars to radius per CRSI recommendations. Roll bars if located in critical areas with tight placing tolerances where straight bars sprung in place to fit would not be satisfactory.

D. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

E. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   1. Shop- or field-weld reinforcement according to AWS D1.4, only where indicated on plans.
   2. Minimum cover requirements for reinforcing steel:

      a. Conc. cast against/permanently exposed to earth: 3 inches
      b. Conc. exposed to earth/water: 2 inches
      c. Conc. slabs and walls not exposed to earth/water: 1 inch
      d. Conc. beams/columns not exposed to earth/water: 1.5 inches

F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

G. Clips, wire ties, spacers, or any material installed to support the reinforcing steel shall not be in contact with the forms in any location.

H. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

I. Contractor must submit plans for alternate splices for review.

J. Length of lap shall be made in accordance with ACI 318, latest revision.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
3. Avoid locating joints in beams, girders, and joists. If required, locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against existing concrete surfaces.

C. Control Joints in Slabs-on-Grade: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness. Form control joints (saw joints) with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than ½ inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Dowel Joints: Install dowel sleeves and dowels or slick steel dowel bar and support assemblies at joints where indicated. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 WATERSTOPS

A. Install all waterstops within 8 months after date of manufacture.

B. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

C. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding,

mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.7 CONCRETE PLACEMENT

A. Before placing concrete, verify that previously placed concrete has attained sufficient strength to bear the weight of new concrete; and that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. All debris, mud and water shall be entirely removed from the forms.

C. Water may be added at the jobsite provided the following conditions are met:

1. The approval of the Engineer is obtained.

2. The maximum slump and water-cementitious ratio is not exceeded after the addition of the water.

3. High-range water-reducing admixtures, if used, are added at the plant and not at the jobsite.

4. The truck can accurately measure the water added.

D. Add water prior to any concrete being discharged (except that used for slump testing). Turn mixing drum an additional 30 revolutions, minimum. No water may be added to the batch at any later time. Air content and slump shall be checked after the water is added.

E. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

F. Deposit concrete in forms in continuous horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints. No more than 30 minutes shall elapse between placement of successive layers.

1. Lifts above horizontal construction joints shall be started with the placement of cement/sand grout having the same water-cement ratio as the concrete and a slump of not more than 6". The grout bed shall be approximately 2" thick, and placement of concrete shall be started as soon as the mortar bed has been spread.
2. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.

G. Placement of concrete in lifts greater than 10 vertical feet shall require prior written approval of the Engineer, unless otherwise shown on the plans.

H. When placing concrete in walls, the concrete shall be deposited in tremies or by other approved methods to prevent segregation and to minimize splatter.

I. When conveying by chutes, the equipment shall be of such size and design as to insure a continuous flow in the chute. The slope shall not be less than 2:1 and shall be such that will prevent segregation of materials. The discharge end of the chute shall not be more than five feet above the surface of the concrete.

J. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required such that no standing water is allowed on the surface.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

K. Concrete in drilled piers shall be placed continuously and in a smooth flow by methods which prevent segregation of ingredients. Temporary casing shall be withdrawn as the concrete is being placed in order to maintain sufficient head of concrete within the casing. The top 5 feet of concrete shall be vibrated after the temporary casing has been withdrawn and dowels/anchor bolts are set.

1. If concrete placement is interrupted, the surface shall be left rough and keyed.
2. If concrete placement is interrupted, the surface shall be doweled as directed by the Engineer.

L. Concrete poured in footing extensions shall be reinforced and shall extend to greater depth than indicated in order to bear on firm ground. Locations around existing footings that have been excavated shall be backfilled with lean concrete.

M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
4. Obtain concurrence of protection measures from the Engineer.

N. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

O. If completion of the pour is prevented, fit the placed concrete with a keyway.

P. If completion of the pour in prevented for walls or water containing structures, fit the placed concrete with a keyway and waterstop.

Q. Prior to resuming concrete placement on the area of the uncompleted pour, the area shall be “green-cut” and coated with a bonding agent as specified.

R. In the case where concrete pours in beams and columns are terminated prior to completion, the pours shall not be restarted until all concrete placed in the incomplete pour has been removed and until all the reinforcement affected has been cleaned and adjusted to the correct location.

3.8 REMOVING AND REUSING FORMS

A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 36 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until the concrete has achieved at least 70 percent of 28-day design compressive strength.
1. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
3. Concrete has attained sufficient strength to withstand any live loads that may be imposed by succeeding steps in the construction process.

C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Engineer.

3.9 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than ½ inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar/grout before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Form tie holes and form bolt holes shall be immediately plugged. Where form ties or form bolts are left in the concrete, such accessories shall be equipped with integral waterstops, and the ends of such accessories shall be equipped with integral waterstops, and the ends of such accessories shall not be closer than one inch (1") to the surface of the concrete. The holes left in each face shall then be primed with a tack coat of grout mixed with an approved accelerator, a stiff mix of mortar with approved accelerator tamped in the holes, and the surfaces finished flush with the concrete surfaces.
   3. In cases where a form bolt of approved through-type is used, the hole left by withdrawal of the form bolt shall be sealed by driving a PVC plug (furnished by the manufacturer of the form bolt) to the mid-point of the length of the hole, by coating the interior surfaces of the hole on each side of the plug with a tack coat of grout mixed with an approved accelerator, by tamping in the hole, on each side of the plug, a stiff mix of mortar with acceptable bonding agent, and by finishing the surfaces of the mortar mix flush with the concrete surfaces.
   4. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   5. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of ¼ inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least ¾ inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.10 CONCRETE FINISHING

A. Formed Finishes

1. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch in height.
2.
   a. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
   b. Do not apply rubbed finish to smooth-formed finish.
3. Rubbed Finish:

   a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until

producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

b. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

4. Applied Finishes:

a. Cement Based Sealer Finish: Prepare and clean cured concrete surfaces, apply base coat, let set 24 hours, then apply finish coat. When finish coat has set, sponge float to provide uniform texture. Coordinate color selection with Engineer.
b. Other Coatings: See Division 9 Section “High Performance Coatings”
c. Maintain all expansion and control joints.

B. Unformed Finishes (Floors and Slabs)

1. General:

a. Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
b. Finish concrete surfaces to designed elevations.
c. Finish concrete surfaces to level below the final finish elevations as correct or suitable for the particular final finish.
d. No water shall stand on the finished floors or slabs.
e. Floors shall be sloped to floor drains and/or sumps such that no standing water shall remain.
f. At tops of walls, horizontal offsets, and similar unformed surfaces 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.

2. Broom Finish: Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
3. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes and apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
4. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture. Apply float finish to surfaces

indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

5. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings. Apply a trowel finish to surfaces indicated and to floor and slab surfaces, including steps and stairs, exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
6. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
7. Hardened/Colored Floors:

    a. Apply only after concrete has cured a minimum of 28 days.
    b. Roughly strike off floors at a level 1-1/2" below finished grade.
    c. Slump of base mix shall not exceed 1-1/2".
    d. All laitance shall be brushed off leaving only coarse aggregate, and a bonding agent shall be used.
    e. Place final topping consisting of a 3,500 psi mix, with 1/8" to 3/8" aggregate, to complete monolithic slab.
    f. Prepare and apply hardener/colorer during the finishing operation according to manufacturer’s recommendations.

8. Special Finishes:

    a. Rough screed floors equipped with sludge collecting mechanisms or sludge scraping mechanisms (clarifiers, sludge thickeners) to an elevation approximately 2 inches below the finished floor elevation. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
    b. Final topping shall be swept in by the mechanism. See section 2.1 for grout requirements.

9. Penetrating Liquid Floor Treatment:

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

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

C. Schedule of Concrete Finishes

1. Sidewalks, curbs, gutters, ramps, and platforms shall receive a broom finish unless otherwise shown or specified.
2. Interior and exterior concrete stair treads shall have a non-slip finish.
3. All interior floors shall be given a monolithic cement top, steel trowel finish unless otherwise shown or specified.

3.11 CONCRETE PROTECTION AND CURING

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
2. Keep concrete poured in walls wet until forms have been removed. Upon removal of the forms, cure the concrete using one or a combination of the specified methods.
3. Concrete finished prior to completion of the project shall be protected from damage by covering with boards and sisal kraft building paper.
4. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
5. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the specified period using one or a combination of the specified methods.
6. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the specified methods.

B. Curing Methods

1. Moisture Curing: Keep surfaces continuously moist for not less than twenty-one days with the following materials:
2.
    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

3. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than twenty-one days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.

4. Curing Compound: Apply curing compound meeting ASTM Designation C-309 uniformly in continuous operation by power spray or roller according to manufacturer's written instructions or at a uniform rate of approximately 150 to 200 sq. ft. per gallon in accordance with ACI 308. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
5. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 MISCELLANEUOS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to sample materials, transport cylinders, perform tests, and submit test reports during concrete placement. The Owner will pay all costs associated with initial tests; including compressive strength testing (4 cylinders per sample as described below), slump, air, temperature and unit weight.

B. Contractor shall pay all costs for re-testing, non-destructive testing, and other additional tests required due to questionable or unsatisfactory concrete.

C. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

D.

1. Sampling Frequency:

    a. When several intermittent pours are made in separate locations during a single day, one (1) sample shall be taken for each eight (8) cubic yards of concrete placed.
    b. When a continuous pour of concrete is made in a single location during a single day, two (2) samples shall be taken for the first twenty-five (25) cubic yards of concrete placed, and one (1) sample shall be taken for each succeeding fifty (50) cubic yards placed, or fraction thereof.
    c. There shall be no concrete poured at any location on the project site(s) that is not represented by a sample (cylinder specimens).

2. Compressive Strength Testing:

    a. Cast and laboratory cure (ASTM C 31/C 31M) one set of four standard cylinder specimens for each composite sample.
    b. Test (ASTM C 39) one (1) laboratory-cured specimen at 7 days and one (1) at 28 days. A third cylinder will be broken at 56 days only if needed, and the fourth cylinder will be considered a spare.
    c. The strength of each concrete mix will be considered satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified 28 day compressive strength and no 28 day

compressive-strength test value falls below 85 percent of the specified compressive strength.

d. When the 28 day compressive strength of a single cylinder falls below 85 percent of the specified strength, a third cylinder shall be broken at 56 days.

e. When the average 28 day compressive cylinder strength of three (3) consecutive cylinders is less than 85 percent of specified strength, the Contractor shall evaluate operations, provide corrective procedures for protecting, and curing in-place concrete, and additional testing may be required at no cost to the Owner.

f. Test results will be reported in writing to Engineer and Contractor within 48 hours of testing. Reports of compressive-strength tests will contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for 7 day, 28-day and 56 day (if required) tests.

g. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted or required by Engineer (at no cost to Owner) but will not be used as sole basis for approval or rejection of concrete.

h. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer at no cost to the Owner.

3. Slump Testing: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.

4. Air Content Testing: ASTM C 231, pressure method, for reinforced concrete; ASTM C 173, volumetric method, for unreinforced concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

E. Testing Concrete Watertightness:

1. The basins, tanks, or any structure to contain liquid shall be so constructed that when completed and tested, there shall be no appreciable loss of water and no wet spots, damp spots or visible moisture shall show. **Testing shall not begin until all visible leaks, damp spots, wet spots..etc have been eliminated. Testing shall be successfully completed prior to backfilling or covering walls, elevated slabs..etc., such that all surfaces of the structure may be visually inspected.**

2. Furnish and install all necessary bulkheads over pipe or gate openings and all necessary pipe plugs to permit proper testing of the structures as soon as possible after completion of the concrete work.
3. Fill water containing structure(s) (basins, tanks...etc.) with water to the overflow line or to the maximum operating level if no overflow exists. The duration of each test (and all retests) shall be a minimum of 72 hours. There are two general requirements for each test:

    a. The first requirement is that no leakage, damp spots, wet spots or visible moisture will be accepted. The second requirement is that the water level must be monitored during the test and the loss of water in the structure cannot exceed one tenth of one percent (0.1%) of the volume of water in the structure in a 24 hour period, excluding evaporation.
    b. If either of these requirements is not met at any time during the test, then the defective structure(s) must be emptied and the leakage must be corrected in a manner acceptable to the Engineers at the Contractor's expense. All repairs must be made by qualified individuals experienced in concrete repair and repair methods must be submitted in writing to the Engineer for review prior to beginning the work.
    c. Once the problem(s) have been addressed, the testing must be performed again and both requirements must be met.
    d. Substantial leakage requiring extensive repair work, such as multiple damp or wet spots in a single area or wall section, shall be cause for removal and replacement of the structure at the discretion of the Engineer, and at no cost to the Owner.
    e. Revise paragraph below if Owner will not be providing water for testing

4. Leakage testing and re-testing shall be included in cost of concrete for payment purposes and full payment will not be made until the concrete has passed leakage tests. This also includes furnishing and installing (temporary or permanent) piping, valves, equipment and other appurtenances required to fill the structures for testing. The Owner will not charge the Contractor for the water required for initial testing. However, the Contractor may, at the Owner's discretion, be charged for the use of water during any retesting.

END OF SECTION 03 30 00

SECTION 03 94 00 - CONCRETE SAWING AND CORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Concrete Sawing
2. Concrete Coring

1.3 SUBMITTALS

A. Include Material Safety Data Sheets, if applicable

B. Shop Drawings: For temporary shoring and supports, prepared by or under the supervision of a qualified professional engineer. Design and engineering of temporary shoring and supports are Contractor's responsibility. Indicate proposed schedule and sequence for removal of temporary shoring and supports.

C. Qualification Data: For installers, professional engineer, and testing agency to demonstrate their capabilities and experience.

1.4 QUALITY ASSURANCE

A. Cutting Contractor Qualifications: In addition to other requirements in Division 1 Section "Quality Requirements," retain cutting contractors that are licensed professionals.

B. Cutting Contractor shall adhere to applicable safety guidelines in accordance with Federal, State, and Local Ordinances.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Notify Engineer seven days in advance of dates when areas of sawing or coring concrete and reinforcing bars will be located.

B. Mark areas of concrete for removal.

2.2 PREPARATION

A. Temporary Support and shoring: Provide temporary support of Work to be cut.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting or coring operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Sawing Area: Lay out area to be cut using a color that does not conflict with color representing other utilities. Spray marking with a clear coat.

E. Coring Area: Lay out area to be cored using a color that does not conflict with color representing other utilities. Spray marking with a clear coat.

F. Over-cut: All cuts shall be within the perimeter of the area to be removed. Approval for any over-cut shall be given by the Engineer prior to any cutting.

2.3 PERFORMANCE

A. General: Employ skilled workers to perform sawing and coring. Proceed with sawing and coring at the earliest feasible time, and complete without delay.

1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Avoid existing utilities located in areas to be cut.
3. Excavating and Backfilling: Comply with requirements in applicable Division 2 Sections where required by cutting operations.
4. Utilities: Locate and turn off all services within the work area.

B. Sawing: Cut existing construction by sawing using methods least likely to damage elements retained or adjoining construction.

1. In general, use hand or small power tools designed for sawing. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Tools: Gas operated saws will only be permitted for use in the outdoors.
3. [Concrete] [Masonry]: Cut using a cutting machine, such as an abrasive saw.
4. Use water or a lubricant to cool the saw blades.

C. Coring: Core existing construction by using coring methods least likely to damage elements retained or adjoining construction.

1. Drill holes over 1 inch in diameter with a non-impact rotary tool in order to minimize spalling at the exit point.
2. Use diamond-core drill bits of the proper size.

3. Use rotary tools that operate below OSHA noise standards.
4. Use water or a lubricant to cool the drill bits.
5. Sealing:

    a. Install a watertight seal between the pipe and the cored hole.
    b. Mechanical seals shall be LINK-SEAL or approved equivalent.

D. Clean-up:

1. Wash or vacuum slurry or tailings generated from [coring][sawing] operations to remove them from the work area. Slurry and tailing shall be disposed of in a location approved by the Engineer.
2. Collect, treat, and dispose of water used in [coring][sawing] operations.
3. Thoroughly clean removal areas of loose concrete, dust, and debris.

E. Patching: Complete any necessary patch work shall be per Section “Cutting and Patching” in Division 1.

2.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to sample materials and perform tests specified in Division 3 Section “Cast-in-Place Concrete".

PART 3 - EXECUTION – NOT USED

END OF SECTION 03 94 00

SECTION 04 20 00 - UNIT MASONRY

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 REFERENCES

A. ASTM C 33 - Standard Specification for Concrete Aggregates.

B. ASTM C 67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.

C. ASTM C 90 - Standard Specification for Loadbearing Concrete Masonry Units.

D. ASTM C 91 - Standard Specification for Masonry Cement.

E. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).

F. ASTM C 140 - Standard Specification for sampling and testing Concrete Masonry Units.

G. ASTM C 150 - Standard Specification for Portland Cement.

H. ASTM C 331 - Standard Specification for Lightweight Aggregates for Concrete Masonry Units.

I. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

J. ASTM C 1019 - Standard Test Method for Sampling and Testing Grout.

K. ASTM C 1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength.

L. ASTM C 1093 - Standard Practice for Accreditation of Testing Agencies for Masonry.

M. ASTM C 1314 - Standard Test Method for Compressive Strength of Masonry Prisms.

N. ASTM C 1506 - Standard Test Method for Water Retention of Hydraulic Cement-Based Mortars and Plasters.

O. ASTM E 514 - Standard Test Method for Water Penetration and Leakage Through Masonry.

P. TMS 402-13 / ACI 530-13 / ASCE 5-13 - Building Code Requirements for Masonry Structures.

Q. TMS 602-13 / ACI 530.1- 13 / ASCE 6-13 - Specification for Masonry Structures.

R. NCMA TEK Bulletin 3-1C - All Weather Concrete Masonry Construction.

S. NCMA TEK Bulletin 3-2A - Grouting for Concrete Masonry Walls.

T. NCMA TEK Bulletin 3-3A - Reinforced Concrete Masonry Construction.

U. NCMA TEK Bulletin 8-2A - Removal of Stains from Concrete Masonry Walls."

V. NCMA TEK Bulletin 10-1A - Crack Control in Concrete Masonry Walls.

W. NCMA TEK Bulletin 10-2B - Control Joints for Concrete Masonry Walls.

X. NCMA TEK Bulletin 19-5A - Flashing Details for Concrete Masonry Walls.

1.3 DESIGN / PERFORMANCE REQUIREMENTS

A. Concrete Unit Masonry Construction: Comply with the following:
   1. TMS 602-13 / ACI 530.1- 13 / ASCE 6-13 - Building Code Requirements for Masonry Structures.
   2. TMS 602-13 / ACI 530.1- 13 / ASCE 6-13 - Specification for Masonry Structures.
   3. National Concrete Masonry Association (NCMA) TEK Bulletins.

B. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in TMS 402/ ACI 530.1/ASCE 5 and TMS 602/ ACI 530.1/ ASCE 6
   2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

1.4 SUMMARY

A. Section Includes:

   1. Concrete masonry units.
   2. Face brick.
   3. Mortar and grout.
   4. Masonry joint reinforcement.
   5. Ties and anchors.
   6. Embedded flashing.
   7. Miscellaneous masonry accessories.
   8. Cavity-wall insulation.

B. Related Sections:

1. Division 03 Section "Pre-Cast Architectural Concrete" for furnishing pre-cast trim.
2. Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
3. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
4. Division 08 Section "Louvers and Vents" for wall vents (brick vents).

1.5 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

C. Samples for Initial Selection:
1. Face brick.
2. Colored mortar.
3. Weep holes/vents.

D. Samples for Verification: For each type and color of the following:
1. Face brick, in the form of straps of five or more bricks.
2. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
3. Weep holes.
4. Accessories embedded in masonry.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

F. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties .
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence according to ASTM C 67.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Pre-blended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

G. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

H. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.

1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high.
2. Clean exposed faces of panels with masonry cleaner indicated.
3. Protect approved sample panels from the elements with weather-resistant membrane.
4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints;

aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Engineer in writing.

a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Engineer in writing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry

damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS

A. Regional Materials: Provide CMUs that have been manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi.
2. Density Classification: Lightweight typical, Normal weight where below grade.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Special shapes: Bullnose units at all outside corners where exposed to view at building interior.

2.3 CONCRETE LINTELS

A. General: Provide one of the following:

B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Division 03 Section "Cast-in-Place Concrete," and with reinforcing bars indicated.

2.4 BRICK

A. Regional Materials: Provide brick that has been manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

C. Face Brick: Facing brick complying with ASTM C 216.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Acme Brick
   b. Caroline Ceramics
   c. Interstate Brick

2. Grade: SW .
3. Type: FBX or FBS .
4. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
5. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
6. Application: Use where brick is exposed unless otherwise indicated.
7.

8. Color and Texture: As selected by Engineer.

2.5 MORTAR AND GROUT MATERIALS

A. Regional Materials: Provide aggregate for mortar and grout, cement, and lime that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

C. Hydrated Lime: ASTM C 207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

E. Masonry Cement: ASTM C 91.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. The Riverton Corporation; Flamingo Color Masonry Cement
   b. Lehigh Cement Company; Lehigh Masonry Cement .
   c. Blue Circle Cement; Magnolia Masonry Cement.
   d. National Cement Company, Inc.; Coosa Masonry Cement
   e. Southdown, Inc; Richcolor Masonry Cement

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

G. Colored Cement Product: Packaged blend made from portland cement and hydrated lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
2. Pigments shall not exceed 10 percent of portland cement by weight.
3. Pigments shall not exceed 5 percent of masonry cement by weight.

H. Aggregate for Mortar: ASTM C 144.

I. Aggregate for Grout: ASTM C 404.

J. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Mill- galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: 0.148-inch diameter.
4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

D. Masonry Joint Reinforcement for Multi-wythe Masonry:
   1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

2.7 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
   1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
   2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 or Type 316.
   3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
   4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   5. Stainless-Steel Bars: ASTM A 276 or ASTM a 666, Type 304.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

   1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
   2. Where wythes do not align , use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
   3. Wire: Fabricate from 3/16-inch- diameter, hot-dip galvanized steel wire.

   4. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

D. Adjustable Masonry-Veneer Anchors:

   1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

      a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.

   2. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:

      a. Products: Subject to compliance with requirements, provide one of the following :

         1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213 .
         2) Heckmann Building Products Inc.; 315-D with 316 or Pos-I-Tie.

3) Hohmann & Barnard, Inc.; DW-10 DW-10HS or DW-10-X.
4) Wire-Bond; 1004, Type III RJ-711 or SureTie.

3. Slip-in, Masonry-Veneer Anchors: Units consisting of a wire tie section and an anchor section designed to interlock with metal studs and be slipped into place as sheathing is installed.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Hohmann & Barnard, Inc.; AA308.

2.8 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.

C. Anchor Bolts: steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.9 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" " and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
3. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
4. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

B. Flexible Flashing: Use the following unless otherwise indicated:

1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.

a. Products: Subject to compliance with requirements, provide one of the following :

1) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
2) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
3) Polyguard Products, Inc.; Polyguard 400.

b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

C. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene .

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use the following unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

a. Products: Subject to compliance with requirements, provide one of the following :
1) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
2) Heckmann Building Products Inc.; No. 85 Cell Vent.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Advanced Building Products Inc.; Mortar Break.
b. Archovations, Inc.; CavClear Masonry Mat.
c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
d. Mortar Net USA, Ltd.; Mortar Net.

2. Provide one of the following configurations:

a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.
b. Strips, not less than the full-depth of cavity and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.
c. Sheets or strips full depth of cavity and installed to full height of cavity.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.11 CAVITY-WALL INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV , closed-cell product extruded with an integral skin.
1. Thickness: As indicated on drawings.

B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.12 MASONRY CLEANERS

A. Job-Mixed Detergent Solution: Solution of ½-cup (0.14-L) dry measure tetrasodium polyphosphate and ½-cup (0.14-L) dry measure laundry detergent dissolved in 1 gal. (4 L) of water.

2.13 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use masonry cement mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls, use Type S.

D. Pigmented Mortar: Use colored cement product

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement by weight.
3. Application: Use pigmented mortar for exposed mortar joints with the following units:
   a. Face brick.
   b. Architectural pre-cast concrete

E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

1. One-half running bond with vertical joint in each course centered on units in courses above and below, unless otherwise noted. **NOTE: BRICK COURSING WITH HEAD JOINTS WHICH DO NOT ALIGN VERTICALLY WILL BE REMOVED AND REPLACED.**

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow brick and CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone or precast architectural concrete trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 1.77 sq. ft. of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.

    a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
    b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.

2. Header Bonding: Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not over 8 inches clear horizontally and 16 inches clear vertically.
3. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Coat cavity face of backup wythe to comply with Division 07 Section "Bituminous Dampproofing."

D. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.7 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:

1. Fasten anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
3. Embed tie sections, connector sections, and continuous wire in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.
4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
5. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally with not less than 1 anchor for each 3.5 sq. ft of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

3.9 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than **3/8 inch** for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.10 LINTELS

A. Install steel lintels where indicated.

B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least **8 inches**.

4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes 24 inches o.c. unless otherwise indicated.
4. Trim wicking material flush with outside face of wall after mortar has set.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.12 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1 / ASCE 6 / TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
7. Clean stone trim to comply with stone supplier's written instructions.

3.14 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property. Refer to Division 1 Section “Construction Waste Management And Disposal.”

END OF SECTION 04 20 00

SECTION 05 12 00 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Structural steel.
   2. Grout.

B. Related sections:
   1. Section 01 41 00 – Structural Tests and Special Inspections.
   2. DEFINITIONS

C. Structural Steel: Elements of structural-steel frame, as classified by AISC “Code of Standard Practice for Steel Buildings and Bridges,” that support design loads.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.

C. Welding certificates.

D. Qualification Data: For Installer and fabricator.

E. Mill Test Reports: Signed by Manufacturers certifying that the following products comply with requirements:
   1. Structural steel including chemical and physical properties.
   2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   3. Shop primers.
   4. Non-shrink grout.

F. Source quality-control test reports.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who regularly erects structural steel with scope and complexity similar to that of this project.

B. Fabricator Qualifications: A qualified fabricator who regularly fabricates structural steel with scope and complexity similar to that of this project.

C. Welding: Qualify procedures and personnel according to AWS D1.1, “Structural Welding Code--Steel.”

D. Comply with applicable provisions of the following specifications and documents:
   1. AISC “Code of Standard Practice for Steel Buildings and Bridges.”
   2. AISC “Seismic Provisions for Structural Steel Buildings” and “Supplement No.2.”
   3. AISC “Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design.”
   4. AISC “Specification for the Design of Steel Hollow Structural Sections.”
   5. AISC “Specification for Allowable Stress Design of Single-Angle Members”.
   6. RCSC “Specifications for Structural Joints Using ASTM F 3125 Bolts.

E. Pre-installation Conference: Conduct conference at Project site.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
   1. Store fasteners in a protected place. Re-lubricate bolts and nuts that become dry.
   2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
   3. Do not clean and use rusty bolts.
   4. COORDINATION

B. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

C. PRODUCTS

1.5 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992.

B. Channels, Angles, and Shapes: ASTMA A 36 unless otherwise noted.

C. Plate and Bar: ASTM A 36 unless otherwise noted.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B structural tubing.

E. Steel Pipe: ASTM A53, Type E or S, Grade B.
   1. Weight Class: Standard unless otherwise indicated.
   2. Finish: Black, except where indicated to be galvanized.

F. Welding Electrodes: Comply with AWS requirements. Tensile strength should be the same or greater than base metal.

1.6 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM F 3125 Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon steel nuts; and ASTM F 436 hardened carbon-steel washers.
   1. Finish: Plain unless noted or indicated otherwise.

B. Un-headed Anchor Rods: ASTM F 1554, Grade 36, unless otherwise indicated.
   1. Configuration: as indicated.
   2. Nuts: ASTM A 563, heavy hex carbon steel.
   3. Plate Washers: ASTM A 36 carbon steel.
   4. Washers: ASTM F 436, hardened carbon steel.
   5. Finish: Plain, unless noted or indicated otherwise.

C. Threaded Rods: ASTM A 36.
   1. Nuts: ASTM A 563 heavy hex carbon steel.
   2. Washers: ASTM F 436 hardened carbon steel.
   3. Finish: Plain, unless noted or indicated otherwise.

D. Clevises or turnbuckles: ASTM A 108, Grade 1035, cold-finished carbon steel.

E. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.

F. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

1.7 PRIMER

A. Primer: Fabricator’s standard lead and chromate free non-asphaltic rust inhibiting primer.

B. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

1.8 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time and complying with Section 03 60 00 GROUT.

1.9 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC “Code of Standard Practice for Steel Buildings and Bridges” and AISC “Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design”.

1. Camber structural-steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, “Power Tool Cleaning.”

F. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.

G. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10” o.c., unless otherwise indicated.

H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces.
2. Base-Plate Holes: Cut, drill, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
4. SHOP CONNECTIONS

I. High-Strength Bolts: Shop install high-strength bolts according to RCSC “Specification for Structural Joints Using ASTM F 3125 Bolts” for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.

J. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC “Code of Standard Practice for Steel Buildings and Bridges” for mill material.
3. SHOP PRIMING

K. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2".
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials.
5. Galvanized surfaces.

L. Surface Preparation: Clean the surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 3, "Power Tool Cleaning."

M. Priming: Immediately after surface preparation, apply primer according to Manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint comers, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

N. Painting: Apply a 1-coat, non-asphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

1.10 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.
1. Fill vent holes and grind smooth after galvanizing.
2. Galvanize all exterior exposed structural steel.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedment, with steel erector present, for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when

permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
2. ERECTION

B. Set structural steel accurately in locations and to elevations indicated and according to AISC “Code of Standard Practice for Steel Buildings and Bridges” and “Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design”.

C. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of base plate.
3. Snug-tighten anchor rods 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 before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and base or bearing; plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow it to cure. Comply with Manufacturer’s written installation instructions for shrinkage-resistant grouts.

D. Maintain erection tolerances of structural steel within AISC “Code of Standard Practice for Steel Buildings and Bridges.”

E. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

F. Splice members only where indicated.

G. Do not use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

2.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC “Specification for Structural Joints Using ASTM F 3125 Bolts” for type of bolt and type of joint specified.

1. Joint Type: Snug tightened, unless noted or indicated otherwise.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
   1. Comply with AISC “Code of Standard Practice for Steel Buildings and Bridges” and “Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design”, for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
   2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
   3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC “Code of Standard Practice for Steel Buildings and Bridges” for mill material.
   4. FIELD QUALITY CONTROL

C. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

D. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC “Specification for Structural Joints Using ASTM F 3125 Bolts.”

E. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

F. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

2.4 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and Manufacturer’s written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
   2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

END OF SECTION 05 12 00

SECTION 05 21 00—STEEL JOIST FRAMING

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 includes the following:

1. K-series open-web steel joists.
2. KCS-series open-web steel joists.
3. Joist accessories

B. Related Sections: The following Sections contain requirements that relate to this Section:

PART 2 -

1. Division 1 Section "Quality Control" for independent testing agency procedures and administrative requirements.
2. Division 3 Section "Cast-in-Place Concrete" for installing anchors set in concrete.
3. Division 4 Section "Unit Masonry" for installing anchors set in unit masonry.
4. Division 5 Section "Structural Steel" for field quality-control procedures and tests.
5. Division 5 Section "Metal Fabrications" for loose, steel bearing plates and miscellaneous steel framing.
6. Division 9 Section "Special Coatings" for surface preparation and prime painting.
7. Division 9 Section "Painting" for surface preparation and prime painting.

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Engineer, fabricate, and erect joists and connections to withstand design loads within limits and under conditions required.

1. Design Loads: As indicated.
2. Design joists to withstand design loads without deflections greater than the following:
   a. Vertical deflection of 1/360 of the span.

B. Engineering Responsibility: Engage a joist manufacturer who utilizes a qualified professional engineer to prepare design calculations, shop drawings, and other structural data for steel joists.

1.04 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the

Contract and Division 1 Specification Sections.

B. Product Data for each type of joist, accessory, and product specified.

C. Shop Drawings showing layout, mark, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, accessories, splice and connection details, and attachments to other units of Work.

1. Indicate locations and details of anchorage devices and bearing plates to be embedded in other construction.
2. For joists indicated to comply with certain design loadings, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Material certificates signed by joist manufacturer certifying that joists comply with SJI's "Specifications."

E. Mill certificates signed by manufacturers of bolts certifying that their products comply with specified requirements.

F. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

G. Qualification data for firms and persons specified in the "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.

H. Research reports or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence joists' compliance with building code in effect for Project.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing joists similar to those indicated for this Project and that have a record of successful in-service performance.

1. Manufacturer must be certified by SJI to manufacture joists conforming to SJI standard specifications and load tables.

B. SJI Design Standard: Comply with recommendations of SJI's "Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders," applicable to types of joists indicated.

C. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel" and AWS D1.3 "Structural Welding Code--Sheet Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

D. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is

experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of joists that are similar to those indicated for this Project in material, design, and extent.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.07 SEQUENCING

A. Deliver steel bearing plates and other devices to be built into concrete and masonry construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel: Comply with requirements of SJI's "Specifications" for chord and web section material.

B. Steel Bearing Plates: ASTM A 36 (ASTM A 36M).

C. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
1. Finish: Plain, noncoated.

D. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
1. Finish: Plain, noncoated.

E. Welding Electrodes: Comply with AWS standards.

2.02 PRIMERS

A. Primer: SSPC-Paint 15, Type I, red oxide; Federal Specification TT-P-636, red oxide; or manufacturer's standard shop primer meeting the performance requirements of either of these red-oxide primers.

B. VOC compliance certificate signed by manufacturers certifying compliance of their products with regulations of authorities having jurisdiction over volatile organic compounds (VOCs).

2.03 STEEL JOIST FRAMING

A. Manufacture joists according to SJI's "Specifications," with steel angle top and bottom chord members, of joist types, end arrangements, and top chord

arrangements indicated.

B. Manufacture joists according to SJI's "Specifications," with steel angle top and bottom chord members, and as follows:
   1. Joist Type: K-series steel joists.
   2. End Arrangement: Underslung with bottom chord extensions.
   3. Top Chord Arrangement: Parallel.

C. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.

D. Provide holes in chord members where shown for securing other work to steel joists.

E. Extend top chords of joists with SJI Type S top chord extensions where indicated, complying with SJI's "Specifications" and load tables.

F. Extend bearing ends of joists with SJI Type R extended ends where indicated, complying with SJI's "Specifications" and load tables.

G. Camber K-series steel joists according to SJI's "Specifications."

H. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes when joist slope exceeds 1/4 inch in 12 inches (1:48).

2.04 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span.

PART 3 -

B. Bridging: Bridging is schematically indicated. Detail and fabricate bridging according to SJI requirements.
   1. Supply additional bridging to ensure stability of structure during construction period.

C. Fabricate steel bearing plates with integral anchorages as indicated and finish as follows:
   1. Finish: Shop prime paint.

D. Steel bearing plates with integral anchorages are specified in Division 5 Section "Metal Fabrications."

E. Supply ceiling extensions, either extended bottom chord elements or a separate extension unit of sufficient strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface, unless otherwise indicated.

F. Supply miscellaneous accessories, including splice plates and bolts required by the joist manufacturer to complete the joist installation.

2.05 SHOP PAINTING

A. Do not shop paint joists to receive fireproofing.

B. Clean and remove loose scale, heavy rust, and other foreign materials from f abricated joists and accessories to be primed as follows:
   1. Surface Preparation: Either hand tool cleaning, SSPC-SP 2, or power tool cleaning, SSPC-SP 3.

C. Apply one shop coat of primer to joists and joist accessories to be primed to provide a continuous, dry paint film thickness of not less than 1 mil (0.025 mm).

D. Surface preparation and painting of joists and joist accessories are included under Division 9 Section "Painting."

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of joists. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's recommendations, and the requirements of this Section.
   1. Before installation, splice joists delivered to Project site in more than one piece.
   2. Space, adjust, and align joists accurately in location before permanently fastening.
   3. Install temporary bracing and bridging, connections, and anchors to ensure joists are stabilized during construction.

C. Field weld joists to supporting steel framework and steel bearing plates. Coordinate welding sequence and procedure with placing of joists.
   1. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: A qualified independent testing agency employed and paid by Owner will perform field quality-control testing.

B. Testing agency will report test results promptly and in writing to Contractor and Architect.

C. Testing and verification procedures will be required of high-strength bolted connections and field welds.
   1. Bolted connections will be visually inspected.
   2. Field-bolted connections will be tested and verified according to procedures in RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."
   3. Field welds will be visually inspected.
   4. In addition to visual inspection, field welds will be inspected and tested according to AWS D1.1 and the following procedures:
      a. Radiographic Testing: ASTM E 94 and ASTM E 142.
      b. Magnetic Particle Inspection: ASTM E 709.
      c. Ultrasonic Testing: ASTM E 164.
      d. Liquid Penetrant Inspection: ASTM E 165.

D. Correct deficiencies in Work that inspections and test reports have indicated are not in compliance with specified requirements.

E. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

3.04 REPAIRS AND PROTECTION

A. Touch Up Painting: Following installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, accessories, bearing plates, and abutting structural steel.
   1. Clean and prepare surfaces by hand tool cleaning, SSPC-SP 2, or power tool cleaning, SSPC-SP 3.
   2. Apply a compatible primer of the same type as the shop primer used on adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that joists and accessories are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 05 21 00

SECTION 05 31 00 - STEEL DECK

GENERAL

1.1 SUMMARY

A. Section includes:
   1. Galvanized roof deck with prime painted bottom surface.

1.2 SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Product Certificates: For each type of steel deck, signed by product manufacturer.

1.3 QUALITY ASSURANCE

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI “North American Specification for the Design of Cold-Formed Steel Structural Members.”

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PRODUCTS

1.5 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Steel Deck:
      a. ASC Profiles, Inc.
      b. Canam Steel Corp.; The Canam Manac Group.
      c. Consolidated Systems, Inc.
      d. DACS, Inc.
      e. D-Mac Industries Inc.
      f. Epic Metals Corporation.
      g. Marlyn Steel Decks, Inc.
      h. New Millennium Building Systems, LLC.
      i. Nucor Corp.; Vulcraft Division.
      j. Roof Deck, Inc.
      k. United Steel Deck, Inc.

l. Valley Joist; Division of EBSCO Industries, Inc.
m. Verco Manufacturing Co.
n. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
o. Approved equal.

1.6 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with “SDI Specifications and Commentary for Steel Roof Deck,” in SDI Publication No. 30, and with the following:
1. Galvanized Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33, and G90 zinc coating.
2. Prime paint underside of galvanized deck with manufacturer’s standard baked on, rust inhibited primer.
3. Deck Profile: Type F, intermediate rib.
4. Profile Depth: 1-1/2”.
5. Design Uncoated-Steel Thicknesses: As indicated.
6. Span Condition: Furnish in longest practical lengths with no individual sheet shorter than that required to span 3 joists.
7. Side Laps: Overlapped or interlocking seam at Contractor’s option.

1.7 ACCESSORIES

A. General: Provide manufacturer’s standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359” design, uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

G. Flat Sump Plate: Single-piece steel sheet, 0.0747” thick, of same material and finish as deck. For drains, cut holes in the field.

H. Galvanizing Repair Paint: ASTM A 780, SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94% zinc/dust by weight.

I. Repair Paint: Manufacturer’s standard rust-inhibitive primer of same color as primer.

EXECUTION

1.8 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

1.9 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

1.10 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members using Buildex #12 screws or approved equal.
   1. Spacing: 36/4 Pattern.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18", and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
   2. Minimum 2 fasteners per span.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2", with end joints as follows:
   1. End Joints: Lapped 2" minimum.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.

E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

1.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner may engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field connections will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Engineer.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

1.12 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation and apply repair paint.
   1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 31 00

SECTION 05 44 00 – COLD-FORMED STEEL TRUSS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Pre-engineered Cold-Formed steel trusses.
   2. Cold-formed steel framing accessories.

B. Related sections:
   1. Section 05 31 00 – Steel Deck.
   2. DEFINITIONS

C. Truss Component Manufacturer: The maker of the components that will be assembled into trusses by the Truss Manufacturer. See MANUFACTURERS for acceptable Truss Component Manufacturer.

D. Truss Manufacturer: An individual or organization engaged in the manufacturing of trusses. See MANUFACTURERS for acceptable Truss Manufacturers.

E. Truss Design Drawing: Written, graphic and pictorial depiction of an individual truss.

F. Truss Design Engineer: Person who is licensed to practice engineering as defined by the legal requirements of the jurisdiction in which the building is to be constructed and who supervises the preparation of the truss design drawings. In this case, the Truss Design Engineer is the Truss Component Manufacturer.

G. Truss Placement Diagram: Illustration identifying the assumed location of each Truss.

1.2 REFERENCES

A. ANSI/AISI/ S100-2012: North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012 edition.

B. ANSI/AISI /S200-12: North American Standard for Cold-Formed Steel Framing - General Provisions; 2012 edition.

C. ANSI/AISI/S202-11: Code of Standard Practice for Cold-Formed Steel Structural Framing; 2011 edition.

D. ANSI/AISI /S214-12: North American Standard for Cold-Formed Steel Framing - Truss Design; 2012 edition.

E. ASTM A 370-14 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products; 2014.

F. ASTM A 500-13 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.

G. ASTM A 653-15 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.

H. ASTM A 780-09 (2015) – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings; 2009 and reapproved in 2015.

I. CFSBCSI - Cold-Formed Steel Building Components Safety Information; Cold-Formed Steel Council (CFSC); 2008 edition with insert for Modifications to Chapters CFSB1, B2, & B3.

J. CFSEI Technical Note 551e - Design Guide for Permanent Bracing of Cold-Formed Steel Trusses; Cold-Formed Steel Engineers Institute; February 1998.

1.3 SUBMITTALS

A. Product Data: Truss Component Manufacturer's descriptive literature for each item of cold-formed metal framing and each accessory specified in this section.

B. Truss Design Drawings: Detailed drawings and calculations prepared by Truss Manufacturer under the supervision of the licensed (State of Alabama) Truss Design Engineer that are in accordance with AISI references. These drawings may also include referenced detail drawings germane to the trusses.

C. Truss Placement Diagram: Diagram that identifies the assumed location of each individually designated truss and references the corresponding Truss Design Drawing.

D. Installation Instructions: Truss Component Manufacturer's printed instructions for handling, storage, and installation of each item of cold-formed metal framing and each accessory specified in this section.

1.4 QUALITY ASSURANCE

A. Provide design of trusses by Truss Component Manufacturer, using design methodologies recommended in AISI references.
   1. Determine mechanical properties of load bearing components by testing in accordance with ASTM A 370-14.
   2. Provide drawings by a Registered Design Professional licensed in the State in which project is to be constructed.
   3. Provide Truss Manufacturer’s Truss Design Drawings.

B. Pre-Installation Meeting: Meet at job site prior to scheduled beginning of installation to review requirements:
   1. Attendees: Require attendance by representatives of the following:
      a. Installer of this section.
      b. Other entities directly affecting, or affected by, construction activities of this section, including but not limited to, the following:
         1) Installer of truss support framing.
         2) Installer of mechanical systems.
         3) Installer of electrical systems.
   2. Review potential interface conflicts; coordinate layout and support provisions.
   3. DELIVERY, STORAGE, AND HANDLING OF STEEL TRUSSES

C. Pack, ship, handle, unload, and lift shop products in accordance with Truss Component Manufacturer's recommendations and in manner necessary to prevent damage or distortion.

D. Store and protect products in accordance with Truss Component Manufacturer's recommendations and in manner necessary to prevent damage, distortion and moisture buildup.

E. PRODUCTS

1.5 MANUFACTURERS

A. Acceptable Truss Component Manufacturer: TrusSteel Products from Alpine TrusSteel, An ITW Company; 2400 Lake Orange Dr, Ste 150, Orlando, FL 32837. Tel: (888) 565-9181. www.TrusSteel.com.

B. Acceptable Truss Manufacturers: Truss components shall be fabricated into completed trusses by one of the following fabricators:
1. Cascade Maunfacturing Company Inc.190 Madsion Street Cascade Iowa 52033.
2. Power Steel Systems 725 Plantation Drive E Heber Springs AR 72543.
3. Southern Components, Inc. 7360 Julie Francis Drive Shrevport LA 71129.

C. Acceptable Truss Manufacturers: Truss components shall be fabricated into completed trusses by fabricators that have at least 5 years worth of experience in the design and supply of Cold-Formed Steel Trusses.

D. Substitutions: Not permitted.

E. Requests for substitutions will be considered.
1. All substitutions must be approved in writing by the Engineer.
2. All applications for substitution must include samples and technical data.
3. COMPONENTS

F. Pre-Engineered, Pre-Fabricated Cold-Formed Steel Trusses: TrusSteel truss components by Alpine TrusSteel, An ITW Company, meeting specified requirements.
1. Truss Type, Span, and Height: As indicated on drawings.
2. Comply with requirements of 2012 Arkansas Fire Prevention Code.
3. Deflection Under Either Live, Snow or Wind Loads (10 year wind speed): 1/180th of span, maximum.
4. Deflection Under Dead plus Live Loads: 1/120th of span, maximum.
5. Shop fabricate in accordance with Truss Design Drawings, using jigging systems to ensure consistent component placement and alignment of components, and to maintain specified tolerances; field fabrication is strictly prohibited unless performed by authorized Truss Manufacturer using Truss Manufacturer’s shop assemblers and proper jigging systems.
6. Shop fabrication of other cold-formed steel framing components into assemblies prior to erection is permitted; fabricate assemblies in accordance with shop drawings.
7. Fasten connections within truss assembly with Truss Component Manufacturer's screws only and as shown on the Truss Design Drawings; welding and other fasteners are prohibited.

8. Fabricate straight, level, and true, without rack, and to the tolerances specified in ANSI/AISI /S214-12:

G. Truss Chord and Web Components: All truss components to be symmetrical in profile and loading orientation, with rolled or closed edges to minimize the danger of cutting during handling; chord and web components without rolled edges are prohibited. Galvanize all truss members and fasteners with G90 coating.
   1. Shapes, Sizes, and Thicknesses: As required to suit design and as indicated on shop drawings.
   2. Chords: Cold-formed from ASTM A 653/A 653M galvanized steel sheet; minimum yield strength of 55,000 psi (380 MPa) for 22, 20, 18 and 16 GA components or 50,000 psi (345 MPa) for 14 GA and 12 GA components; minimum tensile strength of 65,000 psi (448 MPa) for 22, 20, 18, 16, 14, and 12 GA components.
      a. Nominal 28 mil (22 GA) members:
         1) Minimum bare metal thickness: 0.0284 inch (0.72 mm).
         2) Maximum design thickness: 0.0299 inch (0.76 mm).
      b. Nominal 33 mil (20 GA) members:
         1) Minimum bare metal thickness: 0.0329 inch (0.84 mm).
         2) Maximum design thickness: 0.0346 inch (0.88 mm).
      c. Nominal 43 mil (18 GA) members:
         1) Minimum bare metal thickness: 0.0428 inch (1.09 mm).
         2) Maximum design thickness: 0.0451 inch (1.15 mm).
      d. Nominal 54 mil (16 GA) members:
         1) Minimum bare metal thickness: 0.0538 inch (1.37 mm).
         2) Maximum design thickness: 0.0566 inch (1.44 mm).
      e. Nominal 68 mil (14 GA) members:
         1) Minimum bare metal thickness: 0.0677 inch (1.72 mm).
         2) Maximum design thickness: 0.0713 inch (1.81 mm).
      f. Nominal 97 mil (12 GA) members:
         1) Minimum bare metal thickness: 0.0966 inch (2.46 mm).
         2) Maximum design thickness: 0.1017 inch (2.58 mm).
   3. Tube Webs: Cold-formed ASTM A500 steel structural tubing; minimum yield strength of 45,000 psi (310 MPa); minimum tensile strength of 55,000 psi (380 MPa).
      a. Nominal 33 mil (20 GA) members:
         1) Minimum bare metal thickness: 0.033 inch (0.84 mm).
         2) Maximum design thickness: 0.035 inch (0.89 mm).
      b. Nominal 47 mil (18 GA) members:
         1) Minimum bare metal thickness: 0.047 inch (1.19 mm).
         2) Maximum design thickness: 0.049 inch (1.24 mm).
      c. Nominal 63 mil (16 GA) members:
         1) Minimum bare metal thickness: 0.063 inch (1.6 mm).
         2) Maximum design thickness: 0.065 inch (1.65 mm).
   4. Rolled formed Webs: Cold-formed from ASTM A 653/A 653M galvanized steel sheet, minimum G60 coating; minimum yield strength of 40,000 psi (276 MPa) for 20 and 18 GA components or 50,000 psi (345 MPa) for 16 GA components; minimum tensile strength of 55,000 psi (379 MPa) for 20 and 18 GA components or 65,000 psi (448 MPa) for 16 GA components.
      a. Nominal 33 mil (20 GA) members:
         1) Minimum bare metal thickness: 0.0329 inch (0.84 mm).

2) Maximum design thickness: 0.0346 inch (0.88 mm).

b. Nominal 43 mil (18 GA) members:
   1) Minimum bare metal thickness: 0.0428 inch (1.09 mm).
   2) Maximum design thickness: 0.0451 inch (1.15 mm).

c. Nominal 54 mil (16 GA) members:
   1) Minimum bare metal thickness: 0.0538 inch (1.37 mm).
   2) Maximum design thickness: 0.0566 inch (1.44 mm).

H. Fasteners Used in Fabricating Trusses: Fasteners as recommended by Truss Component Manufacturer, bearing stamp of Truss Component Manufacturer for ready identification.

I. EXECUTION

1.6 EXAMINATION

A. Verify that bearing surfaces and substrates are ready to receive steel trusses.

B. Verify that truss bearing surfaces are within the following tolerances:
1. Variation from Level or Specified Plane: Maximum 1/8 inch in 10 feet (6 mm in 3 m).
2. Variation from Specified Position: Maximum 1/4 inch (6 mm).

C. Verify that rough-in utilities and chases that will penetrate plane of trusses are in correct locations and do not interfere with truss, bracing, or bridging placement.

D. Inspect conditions under which installation is to be performed and submit written notification if such conditions are unacceptable to installer.
1. Notify Architect/Building Designer within 24 hours of inspection.
2. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.
3. Beginning construction activities of this section indicates installer's acceptance of conditions.
4. INSTALLATION

E. Install trusses in accordance with Truss Component Manufacturer's instructions and Truss Manufacturer’s Truss Design Drawings and Truss Placement Diagram. Use correct fasteners as previously described.

F. Place components at spacings indicated on the Truss Design Drawings.

G. Install all erection (temporary installation) bracing and permanent bracing and bridging before application of any loads; follow recommendations of the CFSBCSI - Cold-Formed Steel Building Components Safety Information.

H. Install erection bracing - follow recommendations of the CFSBCSI - Cold-Formed Steel Building Components Safety Information.
1. Provide bracing that holds trusses straight and plumb and in safe condition until decking and permanent truss bracing has been fastened to form a structurally sound framing system.

2. All subcontractors shall employ proper construction procedures to ensure adequate distribution of temporary construction loads so that the carrying capacity of any single truss or group of trusses is not exceeded.

I. Install permanent bracing and bridging as shown in the Architect/Building Designer's drawings and notes and in the locations shown shown on the Truss Manufacturer's Truss Design Drawings.

J. Removal, cutting, or alteration of any truss chord, web or bracing member in the field is prohibited, unless approved in advance in writing by the Architect/Building Designer and the Truss Design Engineer.

K. Repair or replace damaged chords, webs, and complete trusses as directed and approved in writing in advance by the Architect/Building Designer and the Truss Component Manufacturer.

1.7 FIELD QUALITY CONTROL

A. Owner will provide inspection service to inspect field connections.

1.8 REPAIRS AND PROTECTION

A. Galvanizing repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel trusses with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to the manufacturer and installer, that ensure the cold-formed steel trusses are without damage or deterioration at the time of substantial completion.

END OF SECTION 05 44 00

SECTION 05 50 00 - METAL FABRICATIONS

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. Steel framing and supports for benches.
   2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
   3. Shelf angles.
   4. Structural-steel door frames.
   5. Miscellaneous steel trim including steel angle corner guards and steel edgings.
   6. Metal bollards.

B. Products furnished, but not installed, under this Section:
   1. Loose steel lintels.
   2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.3 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   1. Temperature Change: 120 deg F , ambient; 180 deg F , material surfaces.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Paint products.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.
   1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. 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.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500, cold-formed steel tubing.

D. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 , Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
   1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

2.4 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
   1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches , with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primer specified in Division 09 Section "High-Performance Coatings" where indicated.

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
   1. Provide mitered and welded units at corners.
   2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with primer specified in Division 09 Section "High-Performance Coatings."

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
   1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Prime exterior steel frames with primer specified in Division 09 Section "High-Performance Coatings."

2.9 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Prime exterior miscellaneous steel trim with primer specified in Division 09 Section "High-Performance Coatings."

2.10 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe .
   1. Where bollards are indicated to receive controls for door operators, provide necessary cutouts for controls and holes for wire.
   2. Where bollards are indicated to receive light fixtures, provide necessary cutouts for fixtures and holes for wire.

B. Prime bollards with primer specified in Division 09 Section "High-Performance Coatings."

2.11 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with primer specified in Division 09 Section "High-Performance Coatings."

2.12 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.13 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize 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.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 50 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Aluminum pipe and tube handrails and railings.

1.3 PERFORMANCE REQUIREMENTS

A. General: In engineering handrails and railings to withstand structural loads indicated, determine allowable design working stresses of handrail and railing materials based on the following:

1. Aluminum: AA 30, "Specifications for Aluminum Structures."

B. Structural Performance of Handrails and Railings: Provide handrails and railings capable of withstanding the following structural loads without exceeding allowable design working stresses of materials for handrails, railings, anchors, and connections:

1. Top Rail of Guards: Capable of withstanding the following loads applied as indicated:

   a. Concentrated load of 200 lbf (890 N) applied at any point and in any direction.
   b. Uniform load of 50 lbf/ft. (730 N/m) applied horizontally and concurrently with uniform load of 100 lbf/ft. (1460 N/m) applied vertically downward.
   c. Concentrated and uniform loads above need not be assumed to act concurrently.

2. Handrails Not Serving As Top Rails: Capable of withstanding the following loads applied as indicated:

   a. Concentrated load of 200 lbf (890 N) applied at any point and in any direction.
   b. Uniform load of 50 lbf/ft. (730 N/m) applied in any direction.
   c. Concentrated and uniform loads above need not be assumed to act concurrently.

3. Infill Area of Guards: Capable of withstanding a horizontal concentrated load of

200 lbf (890 N) applied to 1 sq. ft. (0.09 sq. m) at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area.

a. Load above need not be assumed to act concurrently with loads on top rails in determining stress on guard.

C. Thermal Movements: Provide handrails and 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. 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. Manufacturer's product lines of mechanically connected handrails and railings.
2. Grout, anchoring cement, and paint products.

B. Shop Drawings: Show fabrication and installation of handrails and railings. Include plans, elevations, sections, component details, and attachments to other Work.

1. For installed handrails and railings indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for products with factory-applied color finishes.

D. Samples for Initial Selection: Short sections of railing or flat, sheet metal samples showing available mechanical finishes.

E. Samples for Verification: For each type of exposed finish required, prepared on components indicated below and of same thickness and metal indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1. 6-inch- (150-mm-) long sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.
3. Assembled sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Sample need not be full height.

F. 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 Engineer and owners, and other information specified.

G. Product Test Reports: From a qualified testing agency indicating products comply with requirements, based on comprehensive testing of current products.

1.5 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of handrails and railings that are similar to those indicated for this Project in material, design, and extent.

B. Source Limitations: Obtain each type of handrail and railing through one source from a single manufacturer.

1.6 STORAGE

A. Store handrails and railings in a dry, well-ventilated, weathertight place.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify handrail and railing dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 COORDINATION

A. Coordinate installation of anchorages for handrails and 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.

1.9 SCHEDULING

A. Schedule installation so handrails and railings are mounted only on completed walls. Do not support temporarily by any means that does not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aluminum Pipe and Tube Railings:

a. Alumaguard.
b. Aluminum Tube Railings, Inc.
c. Architectural Art Mfg., Inc.
d. Blum: Julius Blum & Co., Inc.
e. Braun: J.G. Braun Co.
f. CraneVeyor Corp.
g. Hollaender Manufacturing Co.
h. Moultrie Manufacturing Co.
i. Newman Bros., Inc.
j. Sterling Fabricated Systems, Inc.
k. Superior Aluminum Products, Inc.
l. Thompson Fabricating Company.
m. Wagner: R & B Wagner, Inc.

2.2 METALS

A. General: Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.

B. Aluminum: 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.

1. Extruded Bar and Tube: ASTM B 221 (ASTM B 221M), alloy 6063-T5/T52.
2. Extruded Structural Pipe and Tube: ASTM B 429, alloy 6063-T6.
3. Drawn Seamless Tube: ASTM B 210 (ASTM B 210M), alloy 6063-T832.
4. Plate and Sheet: ASTM B 209 (ASTM B 209M), alloy 6061-T6.
5. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), alloy 6061-T6.
6. Castings: ASTM B 26/B 26M, alloy A356-T6.
7. Pipe Railing shall be a minimum of:

a. Nominal 1½" diameter.
b. Schedule 40.
c. 1.610", I.D.
d. 0.145" wall.

8. Post shall be a minimum of:
a. Nominal 1½" diameter.
b. Schedule 40.

C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.3 WELDING MATERIALS, FASTENERS, AND ANCHORS

A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Fasteners for Anchoring Handrails and Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads.

1. For aluminum handrails and railings, use fasteners fabricated from Type 304 or Type 316 stainless steel.

C. Fasteners for Interconnecting Handrail and Railing Components: Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.

1. Provide concealed fasteners for interconnecting handrail and railing components and for attaching them to other work, unless otherwise indicated.
2. Provide concealed fasteners for interconnecting handrail and railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for handrails and railings indicated.
3. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

D. Cast-in-Place and Postinstalled Anchors: Anchors of type indicated below, 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.

1. Cast-in-place anchors.
2. Chemical anchors.
3. Expansion anchors.

2.4 PAINT

A. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

B. Erosion-Resistant 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. 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 handrails and railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble handrails and 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. Form changes in direction of railing members as follows:

1. As detailed.
2. By bending.
3. By radius bends of radius indicated.
4. By flush radius bends.
5. By mitering at elbow bends.
6. By inserting prefabricated flush-elbow fittings.
7. By any method indicated above, applicable to change in direction involved.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

E. Welded Connections: Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

F. Nonwelded Connections: Fabricate handrails and railings by connecting members with concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive where this is manufacturer's standard splicing method.

G. Welded Connections for Aluminum Pipe: Fabricate pipe handrails and railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.

I. Provide inserts and other anchorage devices for connecting handrails and railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.

J. For railing posts set in concrete, provide preset sleeves of steel not less than 6 inches (150 mm) long with inside dimensions not less than ½ inch (12 mm) greater than outside dimensions of post, and steel plate forming bottom closure.

K. For removable railing posts, fabricate slip-fit sockets from steel tube 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.

1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

L. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

M. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

N. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

O. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members that are exposed to exterior or to moisture from condensation or other sources.

P. Fabricate joints that will be exposed to weather in a watertight manner.

Q. Close exposed ends of handrail and railing members with prefabricated end fittings.

R. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of railing and wall is 1/4 inch (6 mm) or less.

S. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

T. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant

material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

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. Provide exposed fasteners with finish matching appearance, including color and texture, of handrails and railings.

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

B. Mechanical Finish: AA-M12 (Mechanical Finish: nonspecular as fabricated).

C. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 607.1.

D. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 607.1.

E. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 606.1 or AAMA 608.1.

1. Color: Light bronze.
2. Color: Medium bronze.
3. Color: Dark bronze.
4. Color: Black.
5. Subparagraphs above are examples only and may vary in color range and availability among manufacturers. Retain one or delete all and retain one of two below.
6. Color: Match Engineer's sample.
7. Color: As selected by Engineer from the full range of industry colors and color densities.

2.9 STAINLESS-STEEL FINISHES

A. Remove or blend tool and die marks and stretch lines into finish.

B. Grind and polish surfaces to produce uniform, directionally textured polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. 180-Grit Polished Finish: Oil-ground, uniform, textured finish.

D. 320-Grit Polished Finish: Oil-ground, uniform, smooth finish.

E. Polished and Buffed Finish: Oil-ground, 180-grit finish followed by buffing.

F. Bright, Directional Polish: No. 4 finish.

G. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required to install handrails and railings. Set handrails and railings accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

1. Do not weld, cut, or abrade surfaces of handrail and 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 (2 mm in 1 m).

3. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).

C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

D. Adjust handrails and railings before anchoring to ensure matching alignment at

abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.

F. Railing shall be provided for all steps and at all other locations as indicated.

G. All railing along walkways over or around basins or pits, or around openings in floor slabs shall be provided with aluminum kickplates (toeplates) in accordance with OSHA Regulations.

H. All railing installed shall fully comply with OSHA requirements.

I. After installation, railings shall be checked for final alignment, using a tightly drawn wire for reference.

J. The maximum misalignment tolerance for railings shall be 1/8 inch in 12 feet.

K. Bent, deformed, or otherwise damaged railings shall be replaced.

L. The use of pop rivets or glue in construction/installation will not be acceptable.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of handrails and railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "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 (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

A. Posts shall be attached to concrete structures by setting in sleeves. (Coordinate with 3.4E)

1. Sleeves shall be rigidly supported in accurate alignment in the forms.
2. Sleeves shall be positioned vertically so that the top of each sleeve is approximately ½ inch below the finished concrete surface.
3. The position of all sleeves shall be carefully measured before railings are fabricated.

4. When the railing is set, the posts shall be wedged in accurate alignment.
5. The annular space between the posts and sleeves shall be filled with handrail setting cement to the top of the steel sleeve.
6. The remaining space shall be filled with sealant.

B. Posts shall be attached to concrete structures by using aluminum floor (foot) flanges. (Coordinate with 3.6C)

1. Aluminum floor (foot) flanges with four stainless steel bolts may be used for:

a. Anchoring railing posts to tops of floor slabs.
b. Anchoring posts to tops of walls with the following provisions:

1) Edge clearance between any bolt and wall face shall not be less than 2".

C. Posts shall be attached to concrete structures by using aluminum side anchor brackets.

1. Aluminum side anchor brackets with four stainless steel bolts may be used for:

a. Securing posts to faces of walls.
b. Securing posts to outside faces of stringers for concrete steps.

D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For aluminum pipe railings, attach posts as indicated using fittings designed and engineered for this purpose.
2. For stainless-steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
3. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

E. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ANCHORING RAILING ENDS

A. Anchor railing ends into concrete and masonry with round flanges connected to railing ends and anchored into wall construction with postinstalled anchors and bolts.
B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces.

1. Weld flanges to railing ends.

2. Connect flanges to railing ends using nonwelded connections.

3.6 ATTACHING HANDRAILS TO WALLS

A. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface.

B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

C. Secure wall brackets 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. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.

5. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

3.7 EXPANSION AND REINFORCEMENT OF RAILINGS

A. Provisions for expansion of railings:

1. Shall be made at regular intervals
2. Shall match location of expansion joints in the structure to which the railing is attached.

B. Aluminum reinforcing bars shall be furnished and installed in posts in order to ensure rigidity of the railing system.

C. Aluminum reinforcing bars shall conform to the following requirements:

1. Reinforcing bars shall be 15" in length,
2. shall be solid aluminum bars,
3. shall be snugly fitted inside of the bottom portion of the post.

3.8 CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.

C. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."

D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.9 PROTECTION

A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the 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 AND STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Metal bar gratings.
2. Heavy-duty metal bar gratings.
3. Metal frames and supports for gratings.
4. Metal Stair Systems

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide gratings capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections:

1. Floors: Capable of withstanding a uniform load of 250 lbf/sq. ft. or a concentrated load of 3000 lbf, whichever produces the greater stress.
2. Walkways and Elevated Platforms Other Than Exits: Capable of withstanding a uniform load of 60 lbf/sq. ft. Limit deflection to L/360 or 1/4 inch, whichever is less.
3. Metal Stairs: Capable of withstanding a uniform load of 100 lbf/sq. ft. Limit deflection to ¼ inch.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Formed-metal gratings.
2. Extruded-aluminum gratings.
3. Clips and anchorage devices for gratings.
4. Paint products.

B. Shop Drawings: Show fabrication and installation details for gratings and metal stair systems. Include plans, elevations, sections, and details of connections. Show all penetrations of grating. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

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.

C. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

D. Welding Certificates: Copies of certificates for welding procedures and personnel.

E. 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 Engineer and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of gratings and or stair systems that are similar to those indicated for this Project in material, design, and extent.

B. Fabricator Qualifications: A firm experienced in producing gratings and or stair systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Metal Bar Grating Standards: Comply with applicable requirements of the following:

1. Non-Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads."
2. Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."

D. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.6 PROJECT CONDITIONS

A. Field Measurements: Where gratings and stair systems are 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. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating gratings without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.7 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, stair frames and supports. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Metal Bar Gratings and Stair Systems:

a. Thompson Fabricating Company
b. Alabama Metal Industries Corp.
c. All American Grating, Inc.
d. Barnett/Bates Corp.
e. Harris Steel Ltd.; Fisher & Ludlow Div.
f. IKG Borden.
g. Klemp Corp.
h. Ohio Gratings, Inc.
i. Seidelhuber Metal Products, Inc.
j. Tru-Weld Grating, Inc.

2.2 ALUMINUM

A. Extruded Bars and Shapes: ASTM B 221, alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.

2.3 FASTENERS

A. Fasteners for Aluminum Gratings: Provide fasteners of aluminum, nonmagnetic stainless steel, zinc-plated steel, or other material warranted by the manufacturer to be compatible with aluminum gratings and other components.

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. Plain Washers: Round, carbon steel, ASME B18.22.1.

D. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.

E. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below 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.

1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.4 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated.

E. Fit exposed connections accurately together to form hairline joints.

F. Welding: Comply with AWS recommendations and 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.

G. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates to fit grating units and weld to units in shop, unless otherwise indicated.
2. Fabricate toeplates for attaching in the field.
3. Toeplate Height: 4 inches, unless otherwise indicated.

2.5 FLOOR GRATINGS

A. Floor gratings shall be furnished and installed as indicated and shall conform to the following requirements:

1. Set in angle frames embedded and anchored in monolithic concrete.
2. Set in angle frames forming metal platforms or walkways.

B. All walkways shall be held firmly in place by removable metal clips.

1. Clips shall not project above surface of grating or walkway.

C. Frames and accessories shall be of same material and finish as grating.

D. Where openings are cut in floor gratings to permit passage of valve stems or for other purposes, such openings shall be banded with 1/8" bar stock of same depth as grating.

E. Floor grating shall conform to the following requirements:

1. Fabricated from straight extruded aluminum I-bars (Alloy 6063-T6) laced together by interlocking cross-bridges or spacers, securely fastened to the bearing bars.
2. Ends of spans shall be closed with flat bars to form box panels.
3. Tread surfaces shall be non-skid type, with longitudinal grooves performed by the extrusion process.
4. Cutouts shall be made in tread surfaces between bearing bars to form alternate rectangular pattern.
5. Grating shall be designed to safely support uniform load of not less than 250 psf; but in no case shall depth of grating be less than 1½".

2.6 METAL BAR GRATINGS

A. Fabricate pressure-locked, rectangular bar aluminum gratings as follows:

1. Grating Mark P-7-4 (1 x 1/8) ALUMINUM: 1-by-1/8-inch bearing bars at 7/16 inch o.c., and crossbars at 4 inches o.c.
2. Grating Mark P-15-4 (1-1/2 x 3/16) ALUMINUM: 1-1/2-by-3/16-inch bearing bars at 15/16 inch o.c., and crossbars at 4 inches o.c.
3. Grating Mark P-19-4 (2 x 3/16) ALUMINUM: 2-by-3/16-inch bearing bars at 1-3/16 inches o.c., and crossbars at 4 inches o.c.
4. Grating Mark: As indicated, but with bearing bar size not less than that required to comply with structural performance requirements.

B. Fabricate pressure-locked, I-bar aluminum gratings as follows:

1. Grating Mark P-15-2 (1 I-Bar) ALUMINUM: 1-inch I-bar bearing bars at 15/16 inch o.c., and crossbars at 2 inches o.c.
2. Grating Mark P-19-4 (1-1/2 I-Bar) ALUMINUM: 1-1/2-inch I-bar bearing bars at 1-3/16 inches o.c., and crossbars at 4 inches o.c.
3. Grating Mark: As indicated.
4. Grating Mark: As indicated, but with bearing bar size not less than that required to comply with structural performance requirements.

C. Fabricate welded, heavy-duty steel gratings as follows:

1. Grating Mark W-19-4 (2 x 1/4) STEEL: 2-by-1/4-inch bearing bars at 1-3/16 inches o.c., and crossbars at 4 inches o.c.
2. Grating Mark W-30-4 (3 x 3/8) STEEL: 3-by-3/8-inch bearing bars at 1-7/8 inches o.c., and crossbars at 4 inches o.c.
3. Grating Mark W-38-4 (5 x 3/8) STEEL: 5-by-3/8-inch bearing bars at 2-3/8 inches o.c., and crossbars at 4 inches o.c.
4. Grating Mark: As indicated.

5. Grating Mark: As indicated, but with bearing bar size not less than that required to comply with structural performance requirements.

D. Aluminum Finish: As follows:

1. Mill.

E. Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

1. Provide not less than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
2. Provide not less than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch or less in thickness and spaced 15/16 inch or more o.c., with each clip designed and fabricated to fit over two bearing bars.
3. Provide not less than four weld lugs for each grating section composed of rectangular bearing bars 3/16 inch or less in thickness and spaced less than 15/16 inch o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
4. Provide not less than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
5. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

    a. Available Product: Subject to compliance with requirements, a product that may be incorporated into the Work includes, but is not limited to, "Grate-Fast" by Struct-Fast Inc.

    b. Product: Subject to compliance with requirements, provide "Grate-Fast" by Struct-Fast Inc.

F. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of the same size and material as bearing bars.

G. Do not notch bearing bars at supports to maintain elevation.

2.7 GRATING FRAMES AND SUPPORTS

A. Aluminum Frames: Fabricate frames for aluminum gratings from extruded-aluminum shapes to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections. Cut, drill, and tap units to receive hardware and similar items.

B. Equip units with integrally welded anchors for casting into concrete or building into masonry.

1. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

2.8 METAL STAIRS

A. Metal Stairs: Metal stairs and anchorages shall be designed, stamped and sealed by a professional engineer in accordance with the “quality Assurance” section of this specification.

B. Metal Stairs shall be of aluminum construction.

C. The metal stair shall generally conform in size to those indicated within the Construction Documents.

D. Stair system provider shall ensure that the system provided meets all codes and regulations, OSHA or otherwise.

E. Metal stairs shall be manufactured by one single entity. This is inclusive of, but not limited to: structural members, stair treads, stair stringers, handrails and connections.

F. The stair system shall meet the design load specified in the “Performance Requirements” section of this specification and any applicable regulations for stairs. Whichever is stricter.

G. Stair treads and landings should have an anti skid top finish and shall be constructed of aluminum grating.

2.9 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish gratings, frames, and supports after assembly.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings and stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Grating frames shall be embedded into new concrete faces unless grating is being installed on an existing surface.

C. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

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. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

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.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach non-removable units to supporting members by welding where both materials are the same; otherwise, fasten by bolting as indicated above.

3.3 INSTALLING METAL STAIRS

A. General: Install stairs to comply with recommendations of metal stair standards that apply to metal stairs of type and size indicated, including installation clearances and standard anchoring details.

B. Anchor metal stairs to adjacent structure and floor.

END OF SECTION 05 53 00

SECTION 07 27 00 - UNDER-SLAB VAPOR BARRIER

PART 1 – GENERAL

1.1 SUMMARY

A. Products supplied under this section:

1. Vapor barrier and installation accessories for installation under concrete slabs.

B. Related sections:

1. Section 03 30 00 Cast-in-Place Concrete
2. Section 07 26 00 Vapor Retarders

1.2 REFERENCES

A. ASTM International:

1. ASTM E1745-17 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
2. ASTM E1643-18a Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

B. Technical Reference - American Concrete Institute (ACI):

1. ACI 302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
2. ACI 302.1R-15 Guide to Concrete Floor and Slab Construction.

1.3 SUBMITTALS

A. Quality control/assurance:

1. Summary of test results per paragraph 9.3 of ASTM E1745.
2. Manufacturer’s samples and literature.
3. Manufacturer’s installation instructions for placement, seaming, penetration prevention and repair, and perimeter seal per ASTM E1643.
4. All mandatory ASTM E1745 testing must be performed on a single production roll per ASTM E1745 Section 8.1.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Vapor barrier shall have all of the following qualities:

1. Maintain permeance of less than 0.01 Perms [grains/(ft^2 · hr · inHg)] as tested in accordance with mandatory conditioning tests per ASTM E1745 Section 7.1 (7.1.1-7.1.5).
2. Other performance criteria:

    a. Strength: ASTM E1745 Class A.
    b. Thickness: 15 mils minimum

3. Provide third party documentation that all testing was performed on a single production roll per ASTM E1745 Section 8.1

B. Vapor barrier products:

1. Basis of Design: Stego Wrap Vapor Barrier (15-mil) by Stego Industries LLC., (877) 464-7834 www.stegoindustries.com.
2. Substitutions to be submitted per Specifications

2.2 ACCESSORIES

A. Seams: Basis of Design

1. Stego Tape by Stego Industries LLC

B. Sealing Penetrations of Vapor barrier: Basis of Desig

1. Stego Mastic by Stego Industries LLC
2. Stego Tape by Stego Industries LLC,

C. Perimeter/edge seal: Basis of Design

1. Stego Crete Claw by Stego Industries LLC
2. Stego Term Bar by Stego Industries LLC
3. StegoTack Tape (double-sided sealant tape)

D. Penetration Prevention: Basis of Design

1. Beast Foot by Stego Industries LLC
2. Beast Form Stake by Stego Industries LLC

PART 3 – EXECUTION

3.1 PREPARATION

A. Ensure that subsoil is approved by Architect or Geotechnical Engineer.

1. Level and compact base material.

3.2 INSTALLATION

A. Install vapor barrier in accordance ASTM E1643.

1. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
2. Extend vapor barrier to the perimeter of the slab. If practicable, terminate it at the top of the slab, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments, such as dowels, waterstops, or any other site condition requiring early termination of the vapor barrier. At the point of termination, seal vapor barrier to the foundation wall, grade beam or slab itself.
   Seal vapor barrier to the entire slab perimeter using Stego Crete Claw, per manufacturer's instructions.

END OF SECTION

SECTION 07 41 13 - STANDING SEAM METAL ROOF PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pre-finished, prefabricated, structural standing seam roof system and accessories.

1.2 RELATED SECTION

A. Section 05 10 00 - Structural Metal Framing.

B. Section 05 40 00 - Cold-Formed Metal Framing.

C. Section 06 10 00 - Rough Carpentry.

D. Section 07 60 00 - Flashing and Sheet Metal.

E. Section 07 90 00 - Joint Protection.

1.3 REFERENCES

A. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. ASTM A 755 - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.

C. ASTM A 792 - Standard Specification for Steel Sheet, 55 percent Aluminum-Zinc Alloy-Coated by the Hot- Dip Process.

D. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

E. ASTM E 98 - Reference Radiographs for Inspection of Aluminum and Magnesium Castings.

F. ASTM E 283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

G. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

H. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

I. ASTM E 1514 - Standard Specification for Structural Standing Seam Steel Roof Panel Systems.

J. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.

K. ASTM E 1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.

L. ASTM E 1680 - Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems.

M. ASTM E 2140 - Standard Test Method for Water Penetration of Metal Panel Roof Systems by Static Water Pressure Head.

N. UL 580 - Tests for Uplift Resistance of Roof Assemblies.

O. UL Building Materials Directory.

P. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies.

Q. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings.

R. UL 2218 - Standard for Impact Resistance of Prepared Roof Covering Materials.

S. SMACNA - Architectural Sheet Metal Manual.

T. AISI - Cold Formed Steel Design Manual.

U. Aluminum Association - Aluminum Design Manual.

V. AAMA 621 - Voluntary Specifications For High Performance Organic Coatings On Coil Coated Architectural Hot Dipped Galvanized (Hdg) And Zinc-Aluminium Coated Steel Substrates.

W. AAMA 2605 - Voluntary Specifications For High Performance Organic Coatings On Coil Coated Architectural Hot Dipped Galvanized (Hdg) And Zinc-Aluminium Coated Steel Substrates.

X. MCA - Preformed Metal Wall Guidelines.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Design Data, Test Reports: Provide manufacturer test reports indicating product compliance with requirements.
2. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.
4. Installation methods.

C. Shop Drawings: Submit detailed drawings and panel analysis showing: Profile, gauge of both exterior and interior sheet, location, layout and dimensions of panels, location and type of fasteners, shape and method of attachment of all trim, locations and type of sealants, and installation sequence.

1. Coordination Drawings: Provide elevation drawings and building sections which show panels in relationship to required locations for structural support. Include panel details and details showing attachment to structural support.
2. Other details as may be required for a weathertight installation.

D. Selection Samples: For each material and finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

E. Verification Samples: For each material and finish product specified, two samples, minimum size 12 inches (300 mm) long, representing actual product, color, and patterns.

F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

G. Field Quality Control Reports: Submit manufacture's field representative's quality control and inspection reports regularly during installation.

H. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic cleaning and maintenance of all components.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum of ten years experience in the production of metal roof panels. Demonstrate experience with examples of projects of similar type and exposure.

B. Installer Qualifications: Installer with a minimum of five years experience with projects of similar size and scope with supervisors trained and approved by manufacturer.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.
4. Accepted mock-ups shall be comparison standard for remaining Work.

1.6 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting: Conduct a pre-installation meeting at the job site attended by Owner, Architect, Manufacturer's Technical Representative, Panel Installer, and related trades. Coordinate structural support requirements in relation to roof panel panel system, installation of any separate air/water barriers, treatment of fenestration, roof penetrations and other requirements specific to the project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
B. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.
C. Store panel materials on dry, level, firm, and clean surface. Stack no more than two bundles high. Elevate one end of bundle to allow moisture run-off, cover and ventilate to allow air to circulate and moisture to escape.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

A. Warranty: Provide manufacturer's standard limited warranties for products and finishes.

1. Material Warranty: Standard form in which manufacturer agrees to repair or replace items that fail in materials or workmanship within specified warranty period. Items covered by the warranty include structural performance and finish performance.

a. Warranty Period: Two years from date of Substantial Completion.

2. Paint Finish: Standard form in which paint manufacturer agrees to repair or replace metal panels that evidence deterioration of fluoropolymer finish.

a. Warranty Period: Fluoropolymer finish, thirty years from date Substantial Completion.

b. Warranty Period: Metallic/Mica Fluoropolymer finish, Custom finish, twenty years from date Substantial Completion.

3. Installer's Warranty: Installer's warranty covering the Work of this Section, including all components of roof panels for two years from date of Substantial Completion.
4. Weather-tight Warranty: Twenty years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Fabral, which is located at: 30 Technology Pkwy. Suite 400; Peachtree Corners, GA 300921317; Tel: 770-449-7066; Fax: 717-735-2879; Email: request info (twinthers@fabral.com); Web: http://www.fabral.com

B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 STAND `N SEAM

A. Roof Panels: STAND `N SEAM structural standing seam roof system.

1. Roof Panel Description: Provide to the configurations indicated on the Drawings.

a. Panel: Factory formed except for long panels, curved or tapered panels where recommended by the manufacturer.
b. Panel Width: 16 inch (406 mm).
c. Seam Height: 2-1/2 inch (63 mm).
d. Maximum Panel Length: Factory Formed 47 feet.
e. Minimum Panel Length: 6 feet.

2. Design Loads: Verify panels will withstand design loads indicated without detrimental effects or deflection. Include thermal differential effects between exterior and interior panel facings and resistance to fastener pullout.

a. Calculate wind uplift using ASCE-10
b. Calculate clip spacing
c. Verify stress and deflection of panel meet project design load
d. Verify project design load conditions with ASTM E 1592
e. Verify project design load conditions with UL 580

3. Materials:

a. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1) Thickness:
   a) 0.030 inch
2) Surface:
   a) Smooth, flat
3) Color: As selected from manufacturer's full range.

b. Sealant: Factory applied for factory formed panels.

4. Performance Requirements:

a. Minimum Roof Slope: 1/2:12
b. Hail Resistance: UL 2218, Class 4
c. Fire Resistance: UL 790, Class A
d. Thermal Cycling Test: 100,000 cycles
e. Wind Uplift:

1) UL580: Class 90, #275, 275A, 275B, 319
2) ASTM E 330/ASTM E 1592: Results Vary Depending on Gauge and Panel Thickness.

f. Air Infiltration

1) ASTM E 283: 0.006 cfm/ft2 @ 20 psf
2) ASTM E 1680: No air penetration @ 20 psf

g. Water Penetration

1) ASTM E 331: No Water @ 20 psf
2) ASTM E 1646: No Water @ 20 psf
3) ASTM E 2140: No leakage of standing water

h. Miami Dade NOA (steel & aluminum)

B. Roof Panel Accessories:

1. General: Provide components required for a complete, weather-tight panel system including trim, copings, fasciae, mullions, sills, corner units, panel clips, flashings, sealants, gaskets, fillers, panel closures, and similar items. Match material and finish of metal panels unless otherwise indicated.
2. Miscellaneous Metal Sub-framing and Furring: Provide manufacturer's standard sections as required for support and alignment of metal panel system.
3. Flashing and Trim: Provide flashing and trim formed from same material as metal panels 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 panels.
4. Panel Fasteners: Self-tapping screws recommended by the manufacturer designed to withstand design loads.

5. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are non-staining, and do not damage panel finish.

6. Sealant Tape: Buytl

   a. Joint Sealant: One Part Poly
   b. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

C. Underlayment: Basis of Design: Owens Corning Titanium X30

Breaking Strength	ASTM D146
Pliability	ASTM D146
Loss of Heating	ASTM D146
Unrolling	ASTM D226
Liquid Water Transmission	ASTM D4869
Tear Resistance	ASTM D4073
Dimensional Stability	ASTM F1087
Pliability	CSA A123.3
Moisture Vapor Permeance	ASTM E96
Burst Strength	ASTM D751
Class A Fire^	ASTM E108

1. Underlayment be applied to a properly prepared dry deck that is smooth, clean and free from any depressions, projections or protruding nails. Roof decks should be structurally sound and meet or exceed minimum requirements of the roof deck manufacturer and local building codes. Underlayment must be covered by primary roofing within 30 days of application.
2. Slopes from 4:12 and greater: Underlayment is to be laid out horizontally (parallel) to the eaves with the printed side up. Horizontal laps should be 3 inches and vertical laps should be 6 inches and anchored approximately 1 inch from the edge. End laps in succeeding courses should be located at least 6 feet from the laps in the preceding course. Where the roof meets a wall, extend Underlayment a minimum 4 inches up the wall. Slopes 2:12 to less than 4:12: Cover the deck with 2 layers of underlayment. Begin by fastening a 21-inch wide strip of underlayment along the eaves with the minimal fasteners needed to hold the course in place. Place a full-width sheet over the 21-inch course and overlap each successive course by 50% plus 1 1/2 inches. Additional fasteners may be required in high-wind regions per local building codes. Vertical lap requirements are the same as 4:12 and greater slopes. Underlayment is not recommended for use on slopes less than 2:12 or on vertical surfaces such as walls.

2.3 FINISH

A. Steel Panels and Accessories:

1. Exposed Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 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.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Aluminum Panels and Accessories:

1. Exposed Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 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.

2.4 FABRICATION

A. General: Provide factory-formed metal roof panel system complying with ASTM E 1514.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Form panels in continuous lengths, endlaps are not permitted.

D. Field forming of panels shall be done by factory employees operating the machines.

E. Fabricate metal panel joints with factory-installed butyl sealant that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

F. Sheet Metal Flashing and Trim: Fabricate flashing and trim shall comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to 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 for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
7. Provide to size recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Do not begin installation until substrates have been properly prepared.

D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Install system sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions and in orientation, sizes, and locations indicated. Install panels perpendicular

to supports unless otherwise indicated. Anchor metal panels and other components securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings in conformance with manufacturer's recommendations.
3. Install flashing and trim as metal panel work proceeds.
4. Panels to be in one continuous length, long length roofs must be field formed by Manufacturer.
5. Provide weather-tight 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.
2. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or 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 manufacturer's 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. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so metal roof panels, and factory-applied sealant are completely engaged.

F. Accessory Installation: Install accessories with positive anchorage to building and weather tight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

G. 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 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 achieve 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 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).

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal 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.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Prepare inspection reports.

D. Installer must have installation shop drawings on site at all times.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures

END OF SECTION

SECTION 07 71 00 - MANUFACTURED ROOF SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formed Aluminum Gravel Copings and Stops:
   1. Fascia systems and galvanized water dams. (Type SP)
   2. Formed gutters and downspouts. (AP)

1.2 RELATED SECTIONS

A. Section 07 90 00 - Joint Protection

1.3 REFERENCES

A. ASTM International (ASTM): Standards for aluminum alloy composition.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings: Including but not limited to profiles, accessory items, anchorage and flashing details, interface with adjacent construction, and dimensions.

D. Selection Samples: For each finish product specified, two complete sets of color charts representing manufacturer's full range of available finish options.

E. Verification Samples: For each finish product specified, two sample chips representing actual product, color, and patterns.

1.5 QUALITY ASSURANCE

A. Single Source Requirements: To the greatest extent possible provide products specified in this section by a single manufacturer.

B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish areas designated by Architect.
   2. Do not proceed with remaining work until workmanship is approved by Architect.
   3. Rework mock-up area as required to produce acceptable work.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials and products in strict compliance with

manufacturer's instructions and recommendations and industry standards.

B. Store materials within recommended limits for temperature and humidity recommended by manufacturer. Protect from damage.

C. Store products in manufacturer's labeled packaging until ready for installation.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 SEQUENCING AND SCHEDULING

A. Conference: Convene a pre-installation conference to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Architectural Products Co. Inc.

B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

C. Formed Gutters and Downspouts: Formed Gutters and Downspouts

1. Type: Standard gutters 6” boxed profile.
2. Type: Heavy extruded aluminum downspouts in areas designated on Drawings 4”x6”.
3. Surface Texture: Smooth, standard.
4. Finish: Fluorocarbon, such as Kynar 500 or manufacturer approved equal. Selected from manuf. standards

D. Fascia Systems

1. Fascia: 6063-T52 alloy aluminum.
2. Lengths: Provide in sections, 10 feet (305 cm) long, for field modification.
3. Type: 6” Boxed Profile
4. Surface Texture: Smooth, standard.
5. Finish: Fluorocarbon, such as Kynar 500 or manufacturer approved equal.

PART 3 EXECUTION

3.1 PREPARATION

A. Prepare substrates using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

B. Do not proceed with installation until substrates have been prepared using the methods recommended by the manufacturer and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.

C. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's installation instructions and in proper relationship with adjacent construction.

3.3 CLEANING AND PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07 92 00 - JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sealants.

B. Sealant applications schedule.

1.2 RELATED SECTIONS

A. Concrete Masonry

B. Gypsum Board Assemblies

1.3 REFERENCES

A. AAMA 808.3 - Specification for Exterior Perimeter Sealing Compound.

B. ASTM International (ASTM):

1. ASTM C 510 - Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
2. ASTM C 661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
3. ASTM C 679 - Standard Test Method for Tack-Free Time of Elastomeric Sealants.
4. ASTM C 719 - Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle).
5. ASTM C 794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
6. ASTM C 834 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
7. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants.
8. ASTM C1382 - Standard Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish Systems (EIFS) Joints.
9. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic ElastomersTension.
10. ASTM D 6511 - Standard Test Methods for Solvent Bearing Bituminous Compounds.
11. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
12. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
13. ASTM E 162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
14. ASTM E 662 - Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
15. ASTM G 155 - Standard Practice for Operating Xenon Arc Light Apparatus for

Exposure of Non-Metallic Materials.

C. CAN/CGSB-19. 13-M87 - Sealing Compound, One-Component, Elastomeric, Chemical Curing.

D. FDA regulation 21-CFR-177.2600 - Rubber Articles Intended For Repeated Use.

E. Federal specification TT-S-00230C - Sealing Compound: Elastomeric Type, Single Component (For Calking, Sealing, And Glazing In Buildings And Other Structures).

F. GreenSeal GS-36 Specifications - Standard For Adhesives For Commercial Use.

G. National Science Foundation (NSF) 51 - Food Equipment Materials.

H. South Coast Air Quality Management District (SCAQMD) Rule #1168 - Adhesive And Sealant Applications.

I. Underwriters Laboratory (UL) 723 - Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5 year experience manufacturing similar products.

B. Installer Qualifications: Minimum 2 year experience installing similar products.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship is approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

B. Handling: Handle materials to avoid damage.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer, Basis of Design, or equal: Liquid Nails Brand

B. Substitutions permitted

2.2 SEALANTS

A. Acrylic:

1. Product: TOP GUN 200 Siliconized Acrylic Sealant as manufactured by Liquid Nails Brand.

    a. Product Type: Siliconized acrylic.
    b. Class: ASTM C 834.
    c. VOC (actual): 1.0 %.
    d. Solids by Weight: 80 % minimum.
    e. Hardness: 25 Shore A.
    f. Flash Point: > 200 degrees F (93 degrees C).
    g. Warranty: 50 years.
    h. Color: White – unless otherwise noted

2. Product: TOP GUN 300 Elastomeric Siliconized Acrylic Sealant as manufactured by Liquid Nails Brand.

    a. Product Type: Siliconized acrylic.
    b. Class: ASTM C 920, Grade NS, Class 12.5. ASTM C 834, Type OP, Grade 18. Fed Spec TT-00230C, Type S, Class B.
    c. VOC (actual): 1.0 %.
    d. Solids by Weight: 82 % minimum.
    e. Hardness: Not reported.
    f. Flash Point: > 200 degrees F (93 degrees C).
    g. Warranty: 60 years.

h. Color: White – unless otherwise noted

B. Urethane:

1. Product: TOP GUN 400 Elastomeric Acrylic Urethane Sealant as manufactured by Liquid Nails Brand.

a. Product Type: Proprietary Urethane/ Modified acrylic blend (Siliconized).
b. Class: ASTM C 920, Grade NS, Class 25. ASTM C 834, Type OP, Grade 18. Fed Spec TT-00230C, Type S, Class A. AAMA 808.3.
c. Elongation: 800 %.
d. VOC (actual): < 1.5 % (30 g/L less water.
e. Solids by Weight: 67 % minimum.
f. Hardness: Not reported.
g. Flash Point: > 200 degrees F (93 degrees C).
h. Warranty: Lifetime.
i. Color: White – unless otherwise noted

2.3 SEALANT APPLICATIONS SCHEDULE

A. Application: Masonry Veneer:

1. Sealant: Top Gun 400

B. Application: Rough Carpentry:

1. Sealant: Top Gun 300

C. Application: Miscellaneous Rough Carpentry:

1. Sealant: Top Gun 300

D. Application: Sheathing Roof and Wall:

1. Sealant: Top Gun 300

E. Application: Gypsum Sheathing:

1. Sealant: Top Gun 200

F. Application: Sheathing, Moisture Resistant:

1. Sealant: Top Gun 200

G. Application: Cementitious Sheathing:

1. Sealant: Top Gun 200

H. Application: Exterior Finish Carpentry:

1. Sealant: Top Gun 400

a. Application: Interior Finish Carpentry:

2. Sealant: Top Gun 400

I. Application: Ornamental Woodwork:

1. Sealant: Top Gun 400

J. Application: Wood Trim:

1. Sealant: Top Gun 400

K. Application: Gypsum Board:

1. Sealant: Top Gun 200

L. Application: Plastic Shower & Dressing Compartment:

1. Sealant: Top Gun 400

M. Application: Cultured Marble Countertops:

1. Sealant: Top Gun 400

N. Application: Solid Surface Countertops:

1. Sealant: Top Gun 400

O. Application: Fiber Cement Siding:

1. Top Gun 400

P. Application: Joint Sealants:

1. Sealant: Top Gun 400

Q. Application: Acoustical Joint Sealants:

1. Sealant: Top Gun 400

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved submittals.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 08 11 13 - STEEL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Steel doors.

B. Steel frames.

1.2 RELATED SECTIONS

A. Section 04 20 00 - Unit Masonry; Placement of anchors in masonry construction.

B. Section 08 71 00 - Door Hardware.

C. Section 09 20 00 - Plaster and Gypsum Board: Stucco.

D. Section 09 90 00 - Painting and Coating.

1.3 REFERENCES

A. ASTM A568 - Standard Specification for Steel Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.

B. ASTM A591 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hop-Dip Process

C. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

D. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

E. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

F. ASTM A1011 - Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

G. ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Painted Steel Surfaces for Steel Doors and Frames.

H. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcings.

I. ANSI/SDI A250.6 Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.

J. ANSI/SDI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames; 1998.

K. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.

L. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames (Formerly SDI-105).

M. DHI A115.1G - Installation Guide for Doors and Hardware.

N. SDI 111 - Recommended Standard Details for Steel Doors & Frames.

O. ANSI/NFPA 252 - Fire Tests of Door Assemblies.

P. ANSI/UL 10B - Fire Tests of Door Assemblies.

Q. ANSI/UL 10C - Positive Pressure Fire Tests of Door Assemblies.

R. ANSI/UL 1784 - Air Leakage Tests of Door Assemblies

S. UL - Building Materials Directory; Underwriters Laboratories Inc.

T. WH - Certification Listings; Warnock Hersey International Inc.

U. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Certificates:
   1. Provide manufacturer's certification that products comply with referenced standards as applicable.
   2. Provide evidence of manufacturer's membership in the Steel Door Institute.

D. Shop Drawings:
   1. Show all openings in the door schedule and/or the Drawings.
   2. Provide details of door design, door construction details and methods of assembling sections, hardware locations, anchorage and fastening methods, door frame types and details, anchor types and spacing, and finish requirements.
   3. Provide door, frame, and hardware schedule in accordance with SDI 111.

E. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and finishes.

F. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and finishes.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide all products from a single manufacturer who is a member of the Steel Door Institute.

B. Doors and frames shall conform to the requirements of ANSI A250.8-(R2008) (SDI-100) and other specifications herein named.

C. Fire Rated Doors and Frames: Ratings as indicated on Door Schedule, when tested in accordance with NFPA 252 or UL 10C.

1. Labeled by UL, WH, or other agency acceptable to the authority having jurisdiction.
2. Stairwell Doors: 250 degrees F (121 degrees C) or 450 degrees F (232 degrees C) temperature rise rating as well as the required fire rating.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Products shall be marked with Architect's opening number on all doors, frames, misc. parts and cartons.

B. Upon delivery, inspect all materials for damage; notify shipper and supplier if damage is found.

C. Protect products from moisture, construction traffic, and damage.

1. Store vertically under cover.
2. Place units on 4 inch (102 mm) high wood sills or in a manner that will prevent rust or damage.
3. Do not use non-vented plastic or canvas shelters.
4. Should wrappers become wet, remove immediately.
5. Provide 1/4 inch (6 mm) space between doors to promote air circulation.

1.7 COORDINATION

A. Coordinate with door opening construction and door frame and door hardware installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Products shall be manufactured by a member of the Steel Door Institute:

1. Black Mountain Door.
2. Ceco Door Products.
3. Curries Company.
4. Deansteel Manufacturing Co.
5. Door Components, Inc.
6. Mesker Door, Inc.
7. MPI Manufacturing.
8. Pioneer Industries, Inc.

9. Republic.
10. Security Metal Products Corp.
11. Steelcraft.

B. Substitutions: Not permitted.

2.2 MATERIALS

A. Doors, frames, frame anchors, and hardware reinforcing for each of the levels and models specified shall be provided to meet the requirements of the performance levels specified. The material used in manufacturing these products and components shall comply with ANSI/SDI A250.8. Hardware reinforcing on doors and frames shall comply with ANSI/SDI A250.6. The physical performance levels shall be in accordance with ANSI/SDI A250.4.

B. All steels used to manufacture doors, frames, anchors, and accessories shall meet at least one or more of the following requirements:

1. Cold rolled steel shall conform to ASTM A1008 and A568.
2. Hot rolled, pickled and oiled steel shall comply with ASTM A1011 and A568.
3. Hot dipped zinc coated steel shall be of the alloyed type and comply with ASTM A924 and A653.
4. Steel Sheet, Electrolytic Zinc-Coated shall conform to ASTM A591.

2.3 FRAMES

A. Provide Levels and Models in accordance with ANSI/SDI A250.8 as indicated in the door schedule.

B. Interior frames: Frame configuration and depth as indicated. Minimum thickness as follows:

1. Heavy duty: For use with:

a. Door Model 1 (full flush design): 0.053 inch (1.3 mm) minimum steel frame thickness.

C. Exterior frames: Provide in accordance with ANSI/SDI A250.8 in the frame configuration and depth as indicated on the Drawings. Minimum thickness as follows:

1. Heavy duty: For use with:

a. Door Model (full flush design): 0.053 inch (1.3 mm) minimum steel frame thickness.

D. Provide units of galvanized and primed steel.

E. Provide face welded type frames unless otherwise indicated.

F. Provide frames, other than slip-on drywall type with a minimum of three anchors per jamb suitable for the adjoining wall construction. Provide anchors of not less than 0.042 inch (1.0 mm) in thickness or 0.167 inch (4.2 mm) diameter wire. Frames over 7 feet 6 inches (2286 mm) shall be provided with an additional anchor per jamb.

G. Masonry anchors shall be as provided by the manufacturer to assure performance specified.

H. Base anchors shall be provided, with minimum thickness of 0.042 inch (1.0mm). For masonry wall conditions that do not allow for the use of a floor anchor, an additional jamb anchor shall be provided.

I. Prepare all frames for all mortise template hardware and reinforced only for surface mounted hardware. Drilling and/or tapping shall be completed by others.

J. Minimum hardware reinforcing gages shall comply with Table 4 of ANSI/SDI A250.8.

K. Provide glazing stops and beads where glazed lights are indicated.

2.4 DOORS

A. Interior doors: Provide interior doors in accordance with ANSI/SDI A250.8 and in the configuration and sizes as indicated on the door schedule:

1. Heavy-duty 1-3/4 inches (44.5 mm):

a. Model 1 - Full flush

B. Exterior doors: Provide exterior doors in accordance with ANSI/SDI A250.8 and in the configuration and size as indicated on the door schedule:

1. Level 3 - Extra heavy-duty 1-3/4 inches (44.5 mm):

a. Model 1 - Full flush

C. Face steel sheet shall meet at least one or more of the following requirements:

1. Level 3
a. 0.053 inch (1.3 mm) minimum thickness

D. End closure: The top and bottom of the doors shall be closed with channels or closures. The channels or closures shall have a minimum material thickness of 0.042 inch (1.0 mm).

1. Flush closure channels: Set back face of channel web flush with door top/bottom.

E. Core: Provide in accordance with ANSI/SDI A250.8.

F. Door edge design: Provide in accordance with ANSI/SDI A250.8.

G. Minimum hardware reinforcing gages shall comply with Table 4 of ANSI/SDI A250.8.

H. Provide louvers and vision lights where indicated on the Drawings in accordance with ANSI/SDI A250.8.

I. Provide steel astragals where indicated on the Drawings or where required by the manufacturer's listing.

2.5 FABRICATION

A. Fabricate doors and frames in accordance with ANSI/SDI A250.8.

B. Prime finish: Doors and frames shall be thoroughly cleaned, and chemically treated to ensure maximum paint adhesion. All surfaces of the door and frame exposed to view shall receive a factory applied coat of rust inhibiting primer, either air-dried or baked-on. The finish shall meet the requirements for acceptance stated in ANSI/SDI A250.10 "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."

C. Design clearances: Fabricate doors and frames to maintain the following clearances:

1. The clearance between the door and frame shall be 1/8 inch (3.2 mm) in the case of both single swing and pairs of doors.
2. The clearance between the meeting edges of pairs of doors shall be 3/16 inch (4.8 mm) plus or minus 1/16 inch (1.6 mm). For fire rated applications, the clearances between the meeting edges of pairs of doors shall be 1/8 inch (3.2 mm) plus or minus 1/16 inch (1.6 mm).
3. The clearance measured from the bottom of the door to the bottom of the frame (undercut) shall be a maximum of 3/4 inch (19.1 mm) unless otherwise specified. Fire door undercuts shall comply with ANSI/NFPA 80, "Fire Doors and Fire Windows."
4. The clearance between the face of the door and the stop shall be 1/16 inch (1.6 mm) to 3/32 inch (2.4 mm).
5. All clearances shall be, unless otherwise specified in this document, subject to a tolerance of plus or minus 1/32 inch (0.8 mm).
6. The clearance at the bottom shall be 5/8 inch (15.8 mm).
7. The clearance between the face of the door and doorstop shall be 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm).
8. All clearances shall be, unless otherwise specified, subject to a tolerance of plus or minus 1/32 inch (0.8 mm).

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that project conditions are suitable before beginning installation of frames. Do not begin installation until conditions have been properly prepared.

1. Verify that completed openings to receive knock-down wrap-around frames are of correct size and thickness.
2. Verify that completed concrete or masonry openings to receive butt type frames are of correct size.
3. Verify that drywall construction walls are the correct thickness.

B. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install frames plumb, level, rigid, and in true alignment in accordance with ANSI A250.11.

B. Inspect and install fire rated doors and frames in accordance with NFPA 80.

C. All frames other than slip-on types shall be fastened to the adjacent structure so as to retain their position and stability. Drywall slip-on frames shall be installed in prepared wall openings in accordance with manufacturer's instructions.

D. Install frames as masonry is laid-up. Fill welded wrap-around frames in masonry construction solid with grout. Brace or fasten frame in such a way to prevent pressure of the grout from deforming frame. Coordinate with work specified in Section 04 20 00.

E. Install frames in stucco construction as work progresses. Fill welded wrap-around frames solid with grout where indicated. Brace or fasten frame in such a way to prevent pressure of the grout from deforming frame. Coordinate with work specified in Section 09 24 00.

F. Grout shall be mixed to provide a 4 inch (102 mm) maximum slump consistency, hand troweled into place. Grout mixed to a thin "pumpable" consistency shall not be used.

G. If additives are used in masonry or plaster work during cold weather, field coat the inside of steel frames with a bituminous compound to prevent corrosion.

H. Doors shall be installed and fastened to maintain alignment with frames to achieve maximum operational effectiveness and appearance. Doors shall be adjusted to maintain perimeter clearances specified. Shimming shall be performed by the installer as needed to assure the proper clearances are achieved.

3.3 ADJUST AND CLEAN

A. Adjust doors for proper operation, free from binding or other defects.

B. Clean and restore soiled surfaces. Remove scraps and debris and leave site in a clean condition.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.5 SCHEDULE

A. Refer to Door and Frame Schedule appended to this section.

END OF SECTION

SECTION 08 33 00 - ROLLING SERVICE DOORS STORMTITE™ MODEL 620

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Uninsulated rolling service doors.

1.2 RELATED SECTIONS

A. Section 05500 - Metal Fabrications: Support framing and framed opening.

B. Section 06200 - Finish Carpentry: Wood jamb and head trim.

C. Section 08333 - Security Grilles.

D. Section 08710 - Door Hardware: Product Requirements for cylinder core and keys.

E. Section 09900 - Painting: Field applied finish.

F. Section 16130 - Raceway and Boxes: Conduit from electric circuit to door operator and from door operator to control station.

G. Section 16150 - Wiring Connections: Power to disconnect.

1.3 REFERENCES

A. ANSI/DASMA 108 - American National Standards Institute Standard Method For Testing Sectional Garage Doors And Rolling Doors: Determination Of Structural Performance Under Uniform Static Air Pressure Difference.

B. NFRC 102 - Test Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems.

C. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Element.

D. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

E. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

F. ASTM A 666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

G. ASTM A 924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

H. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

I. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

J. NEMA MG 1 - Motors and Generators.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Details of construction and fabrication.
4. Installation instructions.

C. Shop Drawings: Include detailed plans, elevations, details of framing members, anchoring methods, required clearances, hardware, and accessories. Include relationship with adjacent construction.

D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product, color, and patterns.

F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

G. Operation and Maintenance Data: Submit lubrication requirements and frequency, and periodic adjustments required.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years experience in the fabrication and installation of security closures.

B. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

C. Store materials in a dry, warm, ventilated weathertight location.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 COORDINATION

A. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

1.10 WARRANTY

A. Warranty: Manufacturer’s limited door and operator system, except the counterbalance spring and finish, to be free from defects in materials and workmanship for 3 years or 20,000 cycles, whichever occurs first.

B. Warranty: Manufacturer’s limited door system warranty for 2 years for all parts and components.

C. PowderGuard Finish

1. PowderGuard Premium Applied to curtain, guides, bottom bar, headplates: Manufacturer’s limited Premium Finish warranty for 2 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Overhead Door Corporation, 2501 S. State Hwy. 121, Suite 200, Lewisville, TX 75067. ASD. Tel. Toll Free: (800) 275-3290. Phone: (469) 549-7100. Fax: (972) 906-1499. Web Site: www.overheaddoor.com E- mail: info@overheaddoor.com.

B. Substitutions: CornellCookson, Mckeon Door, Alpine Door. Submit product information for approval.

C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 ROLLING SERVICE DOORS

A. Stormtite Rolling Service Doors: Overhead Door Corporation Model 620.

1. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.

a. Flat profile type F-265i for doors up to 40 feet (12.19 m) wide.
b. Front slat fabricated of:

1) 24 gauge galvanized steel.

c. Back slat fabricated of:

1) 24 gauge galvanized steel.

2. Performance:

a. Through Curtain Sound Rating: Sound Rating: STC-28 (STC-30+ with HZ noise generator) as per ASTM E 90.
b. Installed System Sound Rating: STC-21 as per ASTM E 90.
c. U-factor: 0.91 NFRC test report, maximum U-factor of no higher than 1.00.
d. Air Infiltration: Meets ASHRAE 90.1 & IECC 2012/2015 C402.4.3 Air leakage <1.00 cfm/ft2.

3. Slats and Hood Finish:

a. Galvanized Steel: Slats and hood galvanized in accordance with ASTM A 653 and receive rust-inhibitive, roll coating process, including 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester top coat

1) Powder Coat: Complete Door

(a) PowderGuard Premium powder coat color as selected by the Architect.

4. Weatherseals:

a. Vinyl bottom seal, exterior guide and internal hood seals.

b. Two prime painted steel angles minimum thickness 1/8 inch (3 mm).

5. Guides: Three structural steel angles.
6. Brackets:

a. Hot rolled prime painted steel to support counterbalance, curtain and hood.Powder coat finish , color as selected by Architect.

7. Finish; Bottom Bar, Guides, Headplate and Brackets:

a. PowderGuard Premium powder coat color as selected by the Architect.

8. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch per foot of span. Counterbalance is adjustable by means of an adjusting tension wheel.
9. Hood: Provide with internal hood baffle weatherseal.

a. 24 gauge galvanized steel with intermediate supports as required.

10. Manual Operation: Chain Hoist
~~Electric Motor Operation: Provide UL listed electric operator, size as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second.~~
~~a. Sensing Edge Protection:~~
~~1) Electric sensing edge.~~
~~b. Operator Controls:~~
~~1) Push-button operated control stations with open, close, and stop buttons.~~
~~c. Motor Voltage: Verify with electrical contractor~~

11. Wind Load Design:

a. Standard wind load shall be 20 PSF.

12. Operation: Design door assembly, including operator, to operate for not less than 20,000 cycles.

13. Locking:

a. Two interior bottom bar slide bolts for manually operated doors.

14. Wall Mounting Condition:

a. Face-of-wall mounting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify opening sizes, tolerances and conditions are acceptable.

B. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with Section 16150. Complete wiring from disconnect to unit components.

F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.

G. Install perimeter trim and closures.

H. Instruct Owner’s personnel in proper operating procedures and maintenance schedule.

3.4 ADJUSTING

A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.

B. Adjust hardware and operating assemblies for smooth and noiseless operation.

3.5 CLEANING

A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.

B. Remove labels and visible markings.

C. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 PROTECTION

A. Protect installed products until completion of project.

END OF SECTION

SECTION 08 71 00 DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes: Finish Hardware for door openings, except as otherwise specified herein.

1. Door hardware
2. Keyed cylinders as indicated.

B. References: Comply with applicable requirements of the following standards. Where these standards conflict with other specific requirements, the most restrictive shall govern.

1. Builders Hardware Manufacturing Association (BHMA)
2. NFPA 101 Life Safety Code
3. NFPA 80 -Fire Doors and Windows
4. ANSI-A156.xx- Various Performance Standards for Finish Hardware
5. UL10C – Positive Pressure Fire Test of Door Assemblies
6. ANSI-A117.1 – Accessible and Usable Buildings and Facilities
7. DHI /ANSI A115.IG – Installation Guide for Doors and Hardware

C. Intent of Hardware Groups

1. Should items of hardware not definitely specified be required for completion of the Work, furnish such items of type and quality comparable to adjacent hardware and appropriate for service required.
2. Where items of hardware aren't definitely or correctly specified, are required for completion of the Work, a written statement of such omission, error, or other discrepancy to Architect, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the service intended.

1.2 SUBMITTALS:

A. Special Submittal Requirements: Coordinate submittals of this Section with related Sections to ensure the "design intent" of the system/assembly is understood and can be reviewed together.

B. Product Data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer's installation instructions.
3. Wiring diagrams for each electric product specified. Coordinate voltage with electrical before submitting.
4. Submit 6 copies of catalog cuts with hardware schedule.

C. Shop Drawings - Hardware Schedule: Submit 6 complete reproducible copy of detailed hardware schedule in a vertical format.

1. List groups and suffixes in proper sequence.
2. Completely describe door and list architectural door number.
3. Manufacturer, product name, and catalog number.
4. Function, type, and style.
5. Size and finish of each item.
6. Mounting heights.
7. Explanation of abbreviations and symbols used within schedule.
8. Detailed wiring diagrams, specially developed for each opening, indicating all electric hardware, security equipment and access control equipment, and door and frame rough-ins required for specific opening.

D. Contract Closeout Submittals: Comply with Division 1 including specific requirements indicated.

1. Operating and maintenance manuals: Submit 3 sets containing the following.

   a. Complete information in care, maintenance, and adjustment, and data on repair and replacement parts, and information on preservation of finishes.
   b. Catalog pages for each product.
   c. Name, address, and phone number of local representative for each manufacturer.
   d. Parts list for each product.

2. Copy of final hardware schedule, edited to reflect, "As installed".
3. Copy of final keying schedule
4. As installed “Wiring Diagrams” for each piece of hardware connected to power, both low voltage and 110 volts.
5. One set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

1.3 QUALITY ASSURANCE

A. Comply with Division

1. Regulatory Label Requirements: Provide testing agency label or stamp on hardware for labeled openings.

   a. Provide UL listed hardware for labeled and 20 minute openings in conformance with requirements for class of opening scheduled.
   b. Underwriters Laboratories requirements have precedence over this specification where conflict exists.

2. Single Source Responsibility: Except where specified in hardware schedule, furnish products of only one manufacturer for each type of hardware.

B. Review Project for extent of finish hardware required to complete the Work. Where there is a conflict between these Specifications and the existing hardware, notify the Architect in writing and furnish hardware in compliance with the Specification unless otherwise directed in writing by the Architect.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Package hardware to prevent damage during transit and storage.
3. Mark hardware to correspond with "reviewed hardware schedule".
4. Deliver hardware to door and frame manufacturer upon request.

B. Storage and Protection: Comply with manufacturer's recommendations.

1.5 PROJECT CONDITIONS:

A. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for the proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents.

B. Review Shop Drawings for doors and entrances to confirm that adequate provisions will be made for the proper installation of hardware.

1.6 WARRANTY:

A. Manufacturer’s Warranty:

1. Closers: Ten years
2. Exit Devices: Three Years
3. Locksets & Cylinders: Three years
4. All other Hardware: Two years.

1.7 MAINTENANCE:

1. Special Tools: Provide special wrenches and tools applicable to each different or special hardware component.
2. Maintenance Tools: Provide maintenance tools and accessories supplied by hardware component manufacturer.
3. Delivery, Storage and Protection: Comply with Owner’s requirements for delivery, storage and protection of extra service materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Refer to Architectural Drawings for manufacturers. Manufacturers are approved subject to compliance with requirements of the Contract Documents. Approval of manufacturers other than those listed shall be in accordance with Division 1.

2.2 MATERIALS:

A. Geared Continuous Hinges:

1. Tested and approved by BHMA for ANSI A156.26-1996 Grade 1
2. Anti-spinning through fastener
3. UL10C listed for 3 hour Fire rating
4. Non-handed
5. Lifetime warranty
6. Provide Fire Pins for 3-hour fire ratings
7. Sufficient size to permit door to swing 180 degrees

B. Mortise Type Locks and Latches:

1. Tested and approved by BHMA for ANSI A156.13, Series 1000, Operational Grade 1, Extra-Heavy Duty, Security Grade 2 and be UL10C
2. Fit ANSI A115.1 door preparation
3. Functions and design as indicated in the hardware groups
4. Solid, one-piece, 3/4-inch (19mm) throw, anti-friction latchbolt made of self-lubricating stainless steel
5. Deadbolt functions shall have 1 inch (25mm) throw bolt made of hardened stainless steel
6. Latchbolt and Deadbolt are to extend into the case a minimum of 3/8 inch (9.5mm) when fully extended
7. Auxiliary deadlatch to be made of one piece stainless steel, permanently lubricated
8. Provide sufficient curved strike lip to protect door trim
9. Lever handles must be of forged or cast brass, bronze or stainless steel construction and conform to ANSI A117.1. Levers that contain a hollow cavity are not acceptable
10. Lock shall have self-aligning, thru-bolted trim
11. Levers to operate a roller bearing spindle hub mechanism
12. Mortise cylinders of lock shall have a concealed internal setscrew for securing the cylinder to the lockset. The internal setscrew will be accessible only by removing the core, with the control key, from the cylinder body.
13. Spindle to be designed to prevent forced entry from attacking of lever
14. Provide locksets with 7-pin removable and interchangeable construction core cylinders.
15. Each lever to have independent spring mechanism controlling it
16. Core face must be the same finish as the lockset

C. Exit Devices shall:

1. Tested and approved by BHMA for ANSI 156.3, Grade 1
2. Provide a deadlocking latchbolt
3. Non-fire rated exit devices shall have cylinder dogging.
4. Touchpad shall be “T” style
5. Exposed components shall be of architectural metals and finishes.
6. Lever design shall match lockset lever design
7. Provide strikes as required by application.
8. Fire exit devices to be listed for UL10C

9. UL listed for Accident Hazard
10. Provide vandal resistant or breakaway trim
11. Aluminum vertical rod assemblies are acceptable only when provide with the manufacturers optional top and bottom stainless steel rod guard protectors

D. Cylinders:

1. Provide the necessary cylinder housings, collars, rings & springs as recommended by the manufacturer for proper installation.
2. Provide the proper cylinder cams or tail piece as required to operate all locksets and other keyed hardware items listed in the hardware sets.
3. Coordinate and provide as required for related sections.

E. Door Closers shall:

1. Tested and approved by BHMA for ANSI 156.4, Grade 1
2. UL10C certified
3. Closer shall have extra-duty arms and knuckles
4. Conform to ANSI 117.1
5. Maximum 2 7/16 inch case projection with non-ferrous cover
6. Separate adjusting valves for closing and latching speed, and backcheck
7. Provide adapter plates, shim spacers and blade stop spacers as required by frame and door conditions
8. Full rack and pinion type closer with 1½“ minimum bore
9. Mount closers on non-public side of door, unless otherwise noted in specification
10. Closers shall be non-handed, non-sized and multi-sized.

F. Door Stops: Provide a dome floor or wall stop for every opening as listed in the hardware sets.

1. Wall stop and floor stop shall be wrought bronze, brass or stainless steel.
2. Provide fastener suitable for wall construction.
3. Coordinate reinforcement of walls where wall stop is specified.
4. Provide dome stops where wall stops are not practical. Provide spacers or carpet riser for floor conditions encountered

G. Kickplates: Provide with four beveled edges ANSI J102, 8 inches high by width less 2 inches on single doors and 1 inch on pairs of doors. Furnish oval-head countersunk screws to match finish.

H. Door Bolts: Flush bolts for wood or metal doors.

1. Provide a set of Automatic bolts ANSI/BHMA 156.3 Type 25 for hollow metal label doors.
2. Provide a set of Automatic bolts ANSI/BHMA 156.3 Type 27 at wood label doors.
3. Manual flush bolts ANSI/BHMA 156.16 at openings where allowed local authority.
4. Provide Dust Proof Strike ANSI/BHMA 156.16 at doors with flush bolts without thresholds.

I. Seals: All seals shall be finished to match adjacent frame color. Seals shall be furnished as listed in schedule. Material shall be UL listed for labeled openings.

J. Weatherstripping: Provide at head and jambs only those units where resilient or flexible seal strip is easily replaceable. Where bar-type weatherstrip is used with parallel arm mounted closers install weatherstrip first.

1. Weatherstrip shall be resilient seal of (Neoprene, Polyurethane, Vinyl, Pile, Nylon Brush, Silicone)
2. UL10C Positive Pressure rated seal set when required.

K. Door Bottoms/Sweeps: Surface mounted or concealed door bottom where listed in the hardware sets.

1. Door seal shall be resilient seal of (Neoprene, Polyurethane, Nylon Brush, Silicone)
2. UL10C Positive Pressure rated seal set when required.

L. Thresholds: Thresholds shall be aluminum beveled type with maximum height of ½" for conformance with ADA requirements. Furnish as specified and per details. Provide fasteners and screws suitable for floor conditions.

2.3 FINISH:

A. Designations used in Schedule of Finish Hardware - 3.5, and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18 including coordination with traditional U.S. finishes shown by certain manufacturers for their products

B. Powder coat door closers to match other hardware, unless otherwise noted.

C. Aluminum items shall be finished to match predominant adjacent material. Seals to coordinate with frame color.

2.4 KEYS AND KEYING:

A. Provide keyed brass cores and keys during the construction period. Construction control and operating keys and core shall not be part of the Owner's permanent keying system or furnished in the same keyway (or key section) as the Owner's permanent keying system. Permanent cores and keys shall be provided at issuance of substantial completion.

B. Keying shall be made to match existing Well No. 3 Treatment Facility.

C. Cylinders, removable and interchangeable core system: Patented MX8 Best 7-pin construction cores.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine doors, frames, related items and conditions under which Work is to be performed and identify conditions detrimental to proper and or timely completion.

1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 HARDWARE LOCATIONS:

A. Mount hardware units at heights indicated in the following publications except as specifically indicated or required to comply with the governing regulations.

1. Recommended Locations for Builder's Hardware for Standard Steel Doors and Frames, by the Door and Hardware Institute (DHI).

2. Recommended locations for Architectural Hardware for flush wood doors (DHI).

3. WDMA Industry Standard I.S.-1A-04, Industry Standard for Architectural wood flush doors.

3.3 INSTALLATION:

A. Install each hardware item per manufacturer's instructions and recommendations. Do not install surface mounted items until finishes have been completed on the substrate. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

B. Conform to local governing agency security ordinance.

C. Install Conforming to ICC/ANSI A117.1 Accessible and Usable Building and Facilities.

D. Installed hardware using the manufacturers fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use "Riv-Nuts" or similar products.

3.4 FIELD QUALITY CONTROL AND FINAL ADJUSTMENT

A. Contractor/Installers, Field Services: After installation is complete, contractor shall inspect the completed door openings on site to verify installation of hardware is complete and properly adjusted, in accordance with both the Contract Documents and final shop drawings.

1. Check and adjust closers to ensure proper operation.

2. Check latchset, lockset, and exit devices are properly installed and adjusted to ensure proper operation.

a. Verify levers are free from binding.

b. Ensure latchbolts and dead bolts are engaged into strike and hardware is functioning.

3. Report findings, in writing, to architect indicating that all hardware is installed and functioning properly. Include recommendations outlining corrective actions for improperly functioning hardware if required.

END OF SECTION 08 71 00

SECTION 09 91 00 - PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior and exterior painting, including surface preparation.

1.2 RELATED SECTIONS

A. Section 05 50 00 - Metal Fabrications.

B. Section 05 70 00 - Decorative Metal.

C. Section 06 20 00 - Finish Carpentry.

D. Section 06 40 00 - Architectural Woodwork.

E. Section 07 60 00 - Flashing and Sheet Metal.

F. Section 09 25 23 - Lime Based Plastering.

1.3 REFERENCES

A. Green Seal Standard GS-11; May 20, 1993.

B. US Green Building Council, (USGBC) - Green Seal standards for LEED paint credits.

C. Occupational Safety and Health Act (OSHA) - Safety Standards.

D. American National Standards Institute (ANSI) - Performance Standards.

E. Paint Decorating Contractors of America (PDCA) - Application Standard.

F. National Paint and Coatings Association (NPCA) - Gloss Standard.

G. American Society for Testing Materials (ASTM) - Testing Methods.

H. Master Paint Institute (MPI #) - Established paint categories and standards.

I. Ozone Transmission Commission (OTC) - Established levels of Volatile Organic Compounds.

J. SCAQMD 1168 - South Coast Air Quality Management District Rule #1168; October 3, 2003.

K. SSPC (PM1) - Steel Structures Painting Manual, Vol. 1, Good Painting Practice; Society for Protective Coatings; 1993, Third Edition.

L. SSPC (PM2) - Steel Structures Painting Manual, Vol. 2, Systems and Specifications; Society for Protective Coatings; 1995, Seventh Edition.

M. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

1.4 DEFINITIONS

A. Commercial as used in this Section refers to a product well suited for a commercial application.

B. DFT as used in this Section refers to the Dry Film Thickness of the coating.

C. Enamel refers to any acrylic or alkyd (oil) base paint which dries leaving an eggshell, pearl, satin, semi-gloss or high gloss enamel finish.

D. DTM as used in this Section refers to paint that is applied Direct To Metal.

E. LEED as used in this Section refers to Leadership in Energy and Environmental Design. Products listed meet LEED criteria for environmentally safe interior primers, paints and coatings.

F. OTC as used in this Section refers to the Ozone Transmission Commission. OTC has established the following VOC levels for the Northeastern United States. Products shall meet the following OTC limits for VOC's.

1. Interior flat paints: 100 grams per liter or less, per gallon.
2. Interior enamels: 150 grams per liter or less, per gallon.
3. Interior stains: 250 grams per liter or less, per gallon.
4. Interior primers: 200 grams per liter or less, per gallon.
5. Rust preventive coatings: 400 grams per liter or less, per gallon.
6. Dry fog coatings: 400 grams per liter or less, per gallon.
7. Floor coatings: 250 grams per liter or less, per gallon.

G. Premium as used in this Section refers to the best quality product "top of the line".

H. VOC as used in this Section refers to Volatile Organic Compounds found in primers, paints, sealers and stains. The level of VOCs appears after each product listed in the Schedule in grams per liter (g/L).

I. Paints are available in a wide range of sheens or glosses, as measured by a gloss meter from a 60 and/or 85 degree angle from vertical, as a percentage of the amount of light that is reflected. The following terms are used to describe the gloss of our products. The list below is provided for general guidance; refer to the technical data sheet for the actual gloss/sheen level for each product.

1. Flat - Less than 5 Percent.
2. Eggshell - 5 - 20 Percent.
3. Satin - 20 - 35 Percent.
4. Semi-Gloss - 30 - 65 Percent.
5. Gloss - Over 65 Percent.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Coordinate with Section 01 30 00 - Administrative Requirements.

C. Product Data: Provide a complete list of all products to be used, with the following

information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category.
2. Cross-reference to specified paint system(s) that the product is to be used in; include description of each system.

D. Samples: Submit three paper samples, 5 inches by 7 inches (127mm x 178mm) in size, illustrating selected colors for each color and system selected with specified coats cascaded.

E. Manufacturer's Instructions: Indicate special surface preparation procedures.

F. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of ten years experience.

B. Installer Qualifications: All products listed in this section are to be applied by a Painting Contractor with a minimum of five years demonstrated experience in surface preparation and field application of the same type and scope as specified.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Mock-up areas designated by Architect.
2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
3. Approved mock-up areas will serve as the standard for remaining Work.
4. Refinish mock-up area as required to produce acceptable Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

C. Disposal:

1. Never pour leftover coating down any sink or drain. Use up material on the job or seal can and store safely for future use.
2. Do not incinerate closed containers.
3. For specific disposal or recycle guidelines, contact the local waste management agency or district. Recycle whenever possible.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within

limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 WARRANTY

A. Inspection of all surfaces to be coated must be done by the manufacturer's representative to insure proper preparation prior to application. All thinners, fillers, primers and finish coatings shall be from the same manufacturer to support a product warranty. Products other than those submitted shall be accompanied by a letter stating its fitness for use and compatibility.

B. At project closeout, provide to the Owner or owner's representative an executed copy of the Manufacturer's standard form outlining the terms and conditions of and any exclusions to their Limited Warranty against Manufacturing Defect.

1.10 EXTRA MATERIALS

A. At project closeout, supply the Owner or owner's representative one gallon of each product for touch-up purposes. Cans shall be clearly marked with color name, number and type of paint.

B. At project closeout, provide the color mixture name and code to the Owner or owner's representative for accurate future color matching.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Benjamin Moore

B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 MATERIALS - GENERAL

A. Volatile Organic Compound (VOC) Content:

1. Provide coatings that comply with the most stringent requirements specified in the following:

a. 40 CFR 59, Subpart D-National Volatile Organic Compound Emission Standards for Architectural Coatings.
b. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

B. Compatibility: Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.3 MIXING AND TINTING

A. Except where specifically noted in this section, all paint shall be ready-mixed and pre-tinted. Agitate all paint prior to and during application to ensure uniform color, gloss, and consistency.

B. Thinner addition shall not exceed manufacturer's printed recommendations. Do not use kerosene or other organic solvents to thin water-based paints.

C. Where paint is to be sprayed, thin according to manufacturer's current guidelines.

2.4 HIGH PERFORMANCE INTERIOR PAINT SYSTEMS

A. CONCRETE - Smooth (Walls and Ceilings, Poured Concrete, Precast Concrete, Unglazed Brick, Cement Board, Tilt-Up, Cast-In-Place).

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97 g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164, LEED 2009, LEED V4.

b. Semi-Gloss Finish High Performance:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97 g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

c. Eggshell/Low Sheen:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97 g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.

2. Epoxy Systems (Solvent Base):

a. Gloss Finish:

1) 1st Coat: Corotech Waterborne Bonding Primer V175, LEED Credit.
2) 2nd Coat: Corotech Polyamide Epoxy V400 (341 g/L), MPI # 82, 98, 108, 177.
3) 3rd Coat: Corotech Polyamide Epoxy V400 (341 g/L), MPI # 82, 98, 108, 177.

3. Urethane System (Water Base):

a. Gloss Finish Single Component:

1) 1st Coat: Corotech Waterborne Bonding Primer V175, LEED Credit.
2) 2nd Coat: Corotech Waterborne Urethane Gloss V540 (10 g/L), LEED Credit.
3) 3rd Coat: Corotech Waterborne Urethane Gloss V540 (10 g/L), LEED Credit.

B. CONCRETE - (Ceilings).

1. MultiSurface Acrylic Coating:

a. Gloss Finish:
1) 1st Coat: Corotech Quick Dry Acrylic Spray DTM Gloss V300 (87 g/L), MPI # 114, LEED Credit, SSPC Paint Spec. 24.
2) 2nd Coat: Corotech Quick Dry Acrylic Spray DTM Gloss V300 (87 g/L), MPI # 114, LEED Credit, SSPC Paint Spec. 24.

2. Dryfall Waterborne Systems:

a. Semi-Gloss Finish:

1) 1st Coat: Coronado Super Kote 5000 Dry Fall Latex Semi-Gloss 112 (67g/L), MPI # 226.
2) 2nd Coat: Coronado Super Kote 5000 Dry Fall Latex Semi-Gloss 112 (67g/L), MPI # 226.

b. Flat Finish:

1) 1st Coat: Coronado Super Kote 5000 Dry Fall Latex Flat N110 (46 g/L), MPI # 118.
2) 2nd Coat: Coronado Super Kote 5000 Dry Fall Latex Flat N110 (46 g/L), MPI # 118.

C. MASONRY - (CMU - Concrete, Split Face, Scored, Smooth, High Density, Low Density, Fluted, Stucco).

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Corotech Acrylic Block Filler V114 (43 g/L), LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164, LEED 2009, LEED V4.

b. Semi-Gloss Finish:

1) 1st Coat Corotech Acrylic Block Filler V114 (43 g/L), LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

c. Low Sheen:

1) 1st Coat: Corotech Acrylic Block Filler V114 (43 g/L), LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.

d. Flat Finish:

1) 1st Coat: Corotech Acrylic Block Filler V114 (43 g/L), LEED 2009.
2) 2nd Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
3) 3rd Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.

2. Epoxy System (Water Base):

a. Gloss Finish:

1) 1st Coat: Corotech Acrylic Block Filler V114 (43 g/L), LEED 2009.
2) 2nd Coat: Corotech Acrylic Epoxy V450 (168 g/L).
3) 3rd Coat: Corotech Acrylic Epoxy V450 (168 g/L).

b. Semi-Gloss/High Luster Finish:

1) 1st Coat: Corotech Acrylic Block Filler V114 (43 g/L), LEED 2009.
2) 2nd Coat: Corotech Waterborne Amine Epoxy V440 (206 g/L).
3) 3rd Coat: Corotech Waterborne Amine Epoxy V440 (206 g/L).
4) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.

c. Eggshell/Low Luster Finish:

1) 1st Coat: Corotech Acrylic Block Filler V114 (43 g/L), LEED 2009.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.

D. Non-Ferrous- (Galvanized and Aluminum):

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec HP Acrylic Metal Primer P04 (47 g/L), MPI # 107, X-Green 107, 134, LEED 2009, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164, LEED 2009, LEED V4.

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164, LEED 2009, LEED V4.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

c. Semi-Gloss Finish:

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Corotech Acrylic DTM Enamel Semi-Gloss V331 (204 g/L), MPI # 153.
3) 3rd Coat: Corotech Acrylic DTM Enamel Semi-Gloss V331 (204 g/L), MPI # 153.

d. Low Sheen:

1) 1st Coat: Benjamin Moore Super Spec HP Acrylic Metal Primer P04 (47 g/L), MPI # 107, X-Green 107, 134, LEED 2009, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low

Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.

3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.

e. Flat Finish:

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.

2. Alkyd System (Solvent Base Finish):

a. Gloss Finish Urethane Modified:

1) 1st Coat: Benjamin Moore Super Spec HP Acrylic Metal Primer P04 (47 g/L), MPI # 107, X-Green 107, 134, LEED 2009, CHPS Certified.
2) 2nd Coat: Benjamin Moore Super Spec HP Urethane Alkyd Gloss Enamel P22 (394 g/L), MPI # 9, 48.
3) 3rd Coat: Benjamin Moore Super Spec HP Urethane Alkyd Gloss Enamel P22 (394 g/L), MPI # 9, 48.

3. Epoxy Systems (Water Base):

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec HP Acrylic Metal Primer P04 (47 g/L), MPI # 107, X-Green 107, 134, LEED 2009, CHPS Certified.
2) 2nd Coat: Corotech Acrylic Epoxy V450 (168 g/L).
3) 3rd Coat: Corotech Acrylic Epoxy V450 (168 g/L).

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec HP Acrylic Metal Primer P04 (47 g/L), MPI # 107, X-Green 107, 134, LEED 2009, CHPS Certified.
2) 2nd Coat: Corotech Acrylic Epoxy V450 (168 g/L).
3) 3rd Coat: Corotech Acrylic Epoxy V450 (168 g/L).

c. Eggshell Finish:

1) 1st Coat: Benjamin Moore Super Spec HP Acrylic Metal Primer P04 (47 g/L), MPI # 107, X-Green 107, 134, LEED 2009, CHPS Certified.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell

V342 (73 g/L), MPI # 151, LEED 2009.

4. Urethane Systems (Water Base):

    a. Gloss Finish:

        1) 1st Coat: Corotech Waterborne Bonding Primer V175, LEED Credit.
        2) 2nd Coat: Corotech Waterborne Urethane Gloss V540 (10 g/L), LEED Credit.
        3) 3rd Coat: Corotech Waterborne Urethane Gloss V540 (10 g/L), LEED Credit.

5. Urethane Systems (Solvent Base):

    a. Gloss Finish:

        1) 1st Coat: Corotech Waterborne Bonding Primer V175, LEED Credit.
        2) 2nd Coat: Corotech Aliphatic Acrylic Urethane Gloss V500 (229 g/L), MPI # 72, 78, 83, 105.
        3) 3rd Coat: Corotech Aliphatic Acrylic Urethane Gloss V500 (229 g/L), MPI # 72, 78, 83, 105.

    b. Semi-Gloss Finish:

        1) 1st Coat: Corotech Waterborne Bonding Primer V175, LEED Credit.
        2) 2nd Coat: Corotech Aliphatic Acrylic Urethane Semi-Gloss V510 (305 g/L), MPI # 83, 174.
        3) 3rd Coat: Corotech Aliphatic Acrylic Urethane Semi-Gloss V510 (305 g/L) MPI # 83, 174.

6. Multi-Surface Acrylic Coating:

    a. Gloss Finish:

        1) 1st Coat: Corotech Quick Dry Acrylic Spray DTM Gloss V300 (87 g/L), MPI # 114, LEED Credit, SSPC Paint Spec. 24.
        2) 2nd Coat: Corotech Quick Dry Acrylic Spray DTM Gloss V300 (87 g/L), MPI # 114, LEED Credit, SSPC Paint Spec. 24.

7. Dryfall Waterborne Systems:

    a. Semi-Gloss Finish:

        1) 1st Coat: Benjamin Moore Dry Fall Latex Semi-Gloss 397 (43 g/L), MPI # 226.
        2) 2nd Coat: Benjamin Moore Dry Fall Latex Semi-Gloss 397 (43 g/L), MPI # 226.

b. Flat Finish:

1) 1st Coat: Benjamin Moore Dryfall Latex Flat 395 (46 g/L), MPI # 118.
2) 2nd Coat: Benjamin Moore Dryfall Latex Flat 395 (46 g/L), MPI # 118.

E. METAL - (Structural Steel Columns, Joists, Trusses, Beams, Miscellaneous and Ornamental Iron, Structural Iron, Ferrous Metal).

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Corotech Acrylic DTM Enamel Gloss V330 (199 g/L), MPI # 154, 164, LEED 2009, LEED V4.
3) 3rd Coat: Corotech Acrylic DTM Enamel Gloss V330 (199 g/L), MPI # 154, 164, LEED 2009, LEED V4.

b. Semi-Gloss Finish:

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Corotech Acrylic DTM Enamel Semi-Gloss V331 (204 g/L), MPI # 153.
3) 3rd Coat: Corotech Acrylic DTM Enamel Semi-Gloss V331 (204 g/L), MPI # 153.

c. Low Sheen:

1) 1st Coat: Benjamin Moore Super Spec HP Acrylic Metal Primer P04 (47 g/L), MPI # 107, X-Green 107, 134, LEED 2009, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.

d. Flat Finish

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd: Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.

2. Alkyd System (Solvent Base Finish):

a. Gloss Finish Urethane Modified:

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Corotech Alkyd Urethane Gloss V200 (336 g/L), MPI # 9, 27, 48.
3) 3rd Coat: Corotech Alkyd Urethane Gloss V200 (336 g/L), MPI # 9, 27, 48.

b. Gloss Finish Urethane Modified:

1) 1st Coat: Benjamin Moore Super Spec HP Acrylic Metal Primer P04 (47 g/L), MPI # 107, X-Green 107, 134, LEED 2009, CHPS Certified.
2) 2nd Coat: Benjamin Moore Super Spec HP Urethane Alkyd Gloss Enamel P22 (394 g/L), MPI # 9, 48.
3) 3rd Coat: Benjamin Moore Super Spec HP Urethane Alkyd Gloss Enamel P22 (394 g/L), MPI # 9, 48.

3. Epoxy Systems (Water Base):

a. Gloss Finish

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Corotech Acrylic Epoxy V450 (168 g/L).
3) 3rd Coat: Corotech Acrylic Epoxy V450 (168 g/L).

b. Semi-Gloss Finish:

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit..
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.

c. Eggshell Finish:

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009

4. Urethane System (Water Base):

a. Gloss Finish:

1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Corotech Waterborne Urethane Gloss V540 (10 g/L), LEED Credit.
3) 3rd Coat: Corotech Waterborne Urethane Gloss V540 (10 g/L), LEED Credit.

5. Urethane System (Solvent Base):

a. Gloss Finish:

1) 1st Coat: Corotech Polyamide Epoxy Primer V150 (330 g/L).
2) 2nd Coat: Corotech Aliphatic Acrylic Urethane Gloss V500 (229 g/L), MPI # 72, 78, 83, 105.
3) 3rd Coat: Corotech Aliphatic Acrylic Urethane Gloss V500 (229 g/L), MPI # 72, 78, 83, 105.

b. Semi-Gloss Finish:

1) 1st Coat: Corotech Polyamide Epoxy Primer V150 (330 g/L).
2) 2nd Coat: Corotech Aliphatic Acrylic Urethane Semi-Gloss V510 (305 g/L), MPI # 83, 174.
3) 3rd Coat: Corotech Aliphatic Acrylic Urethane Semi-Gloss V510 (305 g/L), MPI # 83, 174.

F. METAL - (Ceilings - Structural Steel, Joists, Trusses, Beams).

1. MultiSurface Acrylic Coating:

a. Gloss Finish:

1) 1st Coat: Coronado Rust Scat Waterborne Acrylic Gloss 80 (224 g/L), MPI # 114, 154, LEED Credit.
2) 2nd Coat: Coronado Rust Scat Waterborne Acrylic 80 Line (224 g/L), MPI # 114, 154, LEED Credit.

b. Semi-Gloss Finish:

1) 1st Coat: Corotech Prep All Universal Metal Primer V132 (394 g/L).
2) 2nd Coat: Coronado Super Kote 5000 Dry Fall Latex Semi-Gloss 112 (67g/L), MPI # 226.
3) 3rd Coat: Coronado Super Kote 5000 Dry Fall Latex Semi-Gloss 112 (67g/L), MPI # 226.

c. Eggshell Finish:

1) 1st Coat: Corotech Prep All Universal Metal Primer V132 (394 g/L).
2) 2nd Coat: Coronado Super Kote 5000 Dry Fall Latex Flat N110 (46 g/L), MPI # 118.
3) 3rd Coat: Coronado Super Kote 5000 Dry Fall Latex Flat N110 (46 g/L), MPI # 118.

d. Flat Finish:

1) 1st Coat: Corotech Prep All Universal Metal Primer V132 (394 g/L).
2) 2nd Coat: Coronado Super Kote 5000 Dry Fall Latex Flat N110 (46 g/L), MPI # 118.
3) 3rd Coat: Coronado Super Kote 5000 Dry Fall Latex Flat N110 (46 g/L), MPI # 118.

2. Dryfall Alkyd Topcoats:

a. Flat Finish:

1) 1st Coat: Corotech Prep All Universal Metal Primer V132 (394 g/L).
2) 2nd Coat: Coronado Super Kote 5000 Dry Fall Alkyd Flat 105 (346 g/L), MPI # 55.

G. WOOD- (Doors, Trim, Partitions, Frames).

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Coronado Rust Scat Waterborne Acrylic Gloss 80 (224 g/L), MPI # 114, 154, LEED Credit.
3) 3rd Coat: Coronado Rust Scat Waterborne Acrylic Gloss 80 (224 g/L), MPI # 114, 154, LEED Credit.

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat Coronado Rust Scat Waterborne Acrylic Semi-Gloss 90 (134 g/L), MPI # 153, LEED Credit.
3) 3rd Coat: Coronado Rust Scat Waterborne Acrylic Semi-Gloss 90 (134 g/L), MPI # 153, LEED Credit.

c. Low Sheen/Satin:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.

3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.

d. Flat Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.

2. Alkyd System (Solvent Base Finish):

a. Gloss Finish Urethane Modified:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Alkyd Urethane Gloss V200 (336 g/L), MPI # 9, 27, 48.
3) 3rd Coat: Corotech Alkyd Urethane Gloss V200 (336 g/L), MPI # 9, 27, 48.

3. Epoxy System (Water Base):

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Acrylic Epoxy V450 (168 g/L).
3) 3rd Coat: Corotech Acrylic Epoxy V450 (168 g/L).

b. Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Waterborne Amine Epoxy V440 (206 g/L).
3) 3rd Coat: Corotech Waterborne Amine Epoxy V440 (206 g/L).

c. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.

d. Eggshell Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.

H. DRYWALL - (Walls, Ceilings, Gypsum Board).

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Ultra Spec 500 Interior Latex Primer N534 (0 g/L), MPI # 50, X-Green 50, 149, X-Green 149, LEED 2009, LEED V4, CHPS Certified
2) 2nd Coat: Benjamin Moore Ultra Spec 500 Interior Latex Gloss N540 (0 g/L), MPI # 54, X-Green 54, 147, 147 X-Green, 141, X-Green 141, LEED 2009, LEED V4, CHPS Certified.
3) 3rd Coat: Benjamin Moore Ultra Spec 500 Interior Latex Gloss N540 (0 g/L), MPI # 54, X-Green 54, 147, 147 X-Green, 141, X-Green 141, LEED 2009, LEED V4, CHPS Certified.

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Ultra Spec 500 Interior Latex Primer N534 (0 g/L), MPI # 50, X-Green 50, 149, X-Green 149, LEED 2009, LEED V4, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec 500 Interior Latex Semi-Gloss N539 (0 g/L), MPI # 43, X-Green 43, 146, X-Green 146, 140, X-Green 140, LEED 2009, LEED V4, CHPS Certified.
3) 3rd Coat: Benjamin Moore Ultra Spec 500 Interior Latex Semi-Gloss N539 (0 g/L), MPI # 43, X-Green 43, 146, X-Green 146, 140, X-Green 140, LEED 2009, LEED V4, CHPS Certified.

c. Low Sheen/ Eggshell:

1) 1st Coat: Benjamin Moore Ultra Spec 500 Interior Latex Primer N534 (0 g/L), MPI # 50, X-Green 50, 149, X-Green 149, LEED 2009, LEED V4, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec 500 Latex Eggshell N538 (0 g/L), MPI # 52, X-Green 52, 145, X-Green 145, 139, X-Green 139, LEED 2009, LEED V4, CHPS Certified.
3) 3rd Coat: Benjamin Moore Ultra Spec 500 Latex Eggshell N538 (0 g/L), MPI # 52, X-Green 52, 145, X-Green 145, 139, X-Green 139, LEED 2009, LEED V4, CHPS Certified.

d. Flat Finish:

1) 1st Coat: Benjamin Moore Ultra Spec 500 Interior Latex Primer N534 (0 g/L), MPI # 50, X-Green 50, 149, X-Green 149, LEED 2009, LEED V4, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec 500 Interior Latex Flat N536 (0 g/L), MPI # 53, X-Green 53, 143, X-Green 143, LEED 2009, LEED V4, CHPS Certified.

2. Epoxy Systems (Water Base):

a. Gloss Finish

1) 1st Coat: Benjamin Moore Fresh Start Multi-Purpose Primer N023 (44 g/L), MPI # 6, 17, X-Green 17, 39, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Acrylic Epoxy V450 (168 g/L).
3) 3rd Coat: Corotech Acrylic Epoxy V450 (168 g/L).

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start Multi-Purpose Primer N023 (44 g/L), MPI # 6, 17, X-Green 17, 39, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.

c. Eggshell Finish:

1) 1st Coat: Benjamin Moore Fresh Start Multi-Purpose Primer N023 (44 g/L), MPI # 6, 17, X-Green 17, 39, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.

I. PLASTER - (Walls, Ceilings).

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97 g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec D.T.M. Acrylic Gloss Enamel HP28 (45 g/L), MPI # 114, X-Green 114, 154, X-Green 154, 164,

LEED 2009, LEED V4.

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97 g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

c. Low Sheen Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Low Lustre Enamel HP25 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.

d. Flat Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.

2. Epoxy Systems (Water Base):

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Corotech Acrylic Epoxy V450 (168 g/L).
3) 3rd Coat: Corotech Acrylic Epoxy V450 (168 g/L).

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.

c. Eggshell Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.
3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Eggshell V342 (73 g/L), MPI # 151, LEED 2009.

2.5 EXTERIOR PAINT SYSTEMS (Note: exterior gloss categories are wider than interior, resulting in overlap between gloss and semi-gloss, satin and low lustre)

A. CONCRETE (Cementitious Siding, Flexboard, Transite Board, Shingles (Non-Roof), Common Brick, Stucco, Tilt-up, Precast, and Poured-in-place Cement).

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore Ben Waterborne Exterior Soft-Gloss 543 (45 g/L), MPI # 11.
3) 3rd Coat: Benjamin Moore Ben Waterborne Exterior Soft-Gloss 543 (45 g/L), MPI # 11.

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore Regal Select Exterior High-Build Soft-Gloss N403 (43 g/L), MPI # 11, 311.
3) 3rd Coat: Benjamin Moore Regal Select Exterior High-Build Soft-Gloss N403 (43 g/L), MPI # 11, 311.

c. Satin Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.
3) 3rd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.

d. Flat Finish:

1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
2) 2nd Coat: Benjamin Moore ben Waterborne Exterior Flat 541 (44 g/L), MPI # 10.
3) 3rd Coat: Benjamin Moore ben Waterborne Exterior Flat 541 (44 g/L), MPI # 10.

2. Elastomeric System: Not including cementitious siding, Flexboard, Transite board or shingles (non-roof).

    a. Flat Finish:

        1) 1st Coat: Benjamin Moore Super Spec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
        2) 2nd Coat: Benjamin Moore Super Spec Masonry 100% Acrylic Elastomeric Coating Flat 056 (99 g/L).
        3) 3rd Coat: Benjamin Moore Super Spec Masonry 100% Acrylic Elastomeric Coating Flat 056 (99 g/L).

3. Textured and Smooth Systems:

    a. Textured (Water Based Finish):

        1) 1st Coat: Coronado Texcrete WB Acrylic Masonry Waterproofer Smooth 3194 (90 g/L), LEED Credit.
        2) 2nd Coat:

            a) Finish Texture- Fine: Coronado Texcrete WB Acrylic Masonry Waterproofer Sand Finish 3192 (78 g/L), LEED Credit.
            b) Finish Texture- Smooth: Coronado Texcrete WB Acrylic Masonry Waterproofer Smooth Finish 3194 Line (90 g/L), LEED Credit.
            c) Finish Texture- Medium: Coronado Texcrete WB Acrylic Masonry Waterproofer Medium Finish 3196 Line (20 g/L), MPI # 42, LEED Credit.

    b. Smooth (Water Based Finish):

        1) 1st Coat: Coronado Texcrete WB Acrylic Masonry Waterproofer Smooth Finish 3194 (90 g/L), LEED Credit.
        2) 2nd Coat: Coronado Texcrete WB Acrylic Masonry Waterproofer Smooth Finish 3194 (90 g/L), LEED Credit.

4. Stain System:

    a. Solid Color Waterborne Finish:

        1) 1st Coat: Coronado TuffCrete Waterborne Acrylic Concrete Stain CST-2000 (153 g/L), MPI # 58.
        2) 2nd Coat: Coronado TuffCrete Waterborne Acrylic Concrete Stain CST-2000 (153 g/L), MPI # 58.

B. MASONRY: Concrete Masonry Units (CMU) - Cinder or Concrete Block.

1. Latex Systems:

    a. Gloss Finish:

1) 1st Coat: Coronado Super Kote 5000 Production Block Filler 958-11 (35 g/L), MPI # 4, X-Green 4, LEED V4, CHPS Certified.
2) 2nd Coat: Coronado Cryli Cote 100% Acrylic Gloss House & Trim Paint 2 (94 g/L).
3) 3rd Coat: Coronado Cryli Cote 100% Acrylic Gloss House & Trim Paint 2 (94 g/L).

b. Semi-Gloss Finish:

1) 1st Coat: Coronado Super Kote 5000 Production Block Filler 958-11 (35 g/L), MPI # 4, X-Green 4, LEED V4, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

c. Satin Finish:

1) 1st Coat: Coronado Super Kote 5000 Production Block Filler 958-11 (35 g/L), MPI # 4, X-Green 4, LEED V4, CHPS Certified.
2) 2nd Coat: Coronado Cryli Cote 100% Acrylic Satin House & Trim Paint 410 (83 g/L).
3) 3rd Coat: Coronado Cryli Cote 100% Acrylic Satin House & Trim Paint 410 (83 g/L).

d. Satin Finish - Early Moisture Resistant Finish:

1) 1st Coat: Benjamin Moore Super Spec Masonry Interior/Exterior Hi-Build Block Filler 206 (45 g/L), MPI # 4, X-Green 4, LEED 2009, LEED V4, CHPS Certified.
2) 2nd Coat: Benjamin Moore Regal Select Exterior High-Build Low Lustre N401 (40 g/L), MPI # 15, 315.
3) 3rd Coat: Benjamin Moore Regal Select Exterior High-Build Low Lustre N401 (40 g/L), MPI # 15, 315.

e. Flat Finish:

1) 1st Coat: Coronado Super Kote 5000 Production Block Filler 958-11 (35 g/L), MPI # 4, X-Green 4, LEED V4, CHPS Certified.
2) 2nd Coat: Coronado Cryli Cote 100% Acrylic Flat House & Trim Paint 10 (44 g/L), MPI # 10.
3) 3rd Coat: Coronado Cryli Cote 100% Acrylic Flat House & Trim Paint 10 (44 g/L), MPI # 10.

2. Elastomeric System:

a. Flat Finish

1) 1st Coat: Benjamin Moore Super Spec Masonry Interior/Exterior Hi-Build Block Filler 206 (45 g/L), MPI # 4, X-Green 4, LEED 2009, LEED V4, CHPS Certified.
2) 2nd Coat: Benjamin Moore Super Spec Masonry 100% Acrylic Elastomeric Coating Flat 056 (99 g/L).
3) 3rd Coat: Benjamin Moore Super Spec Masonry 100% Acrylic Elastomeric Coating Flat 056 (99 g/L).

3. Textured Masonry System:

a. Textured (Water Based Finish)

1) 1st Coat: Coronado Texcrete WB Acrylic Masonry Waterproofer Smooth Finish 3194 (90 g/L), LEED Credit.
2) 2nd Coat: Coronado Texcrete WB Textured Waterproofer

a) Finish Texture Sand: 3192 (78 g/L), LEED Credit.
b) Finish Texture Medium: 3196 (20 g/L) MPI # 42, LEED Credit.

b. Smooth (Water Based)

1) 1st Coat: Coronado Texcrete WB Acrylic Masonry Waterproofer Smooth Finish 3194 (90 g/L), LEED Credit.
2) 2nd Coat: Coronado Texcrete WB Acrylic Masonry Waterproofer Smooth Finish 3194 (90 g/L), LEED Credit.

4. Stain System:

a. Solid Color Waterborne Stain Finish:

1) 1st Coat: Insl-X TuffCrete Solvent Acrylic Concrete Stain & Waterproofing Sealer CST-5100 (651 g/L), MPI # 58, 104.
2) 2nd Coat: Insl-X TuffCrete Solvent Acrylic Concrete Stain & Waterproofing Sealer CST-5100 (651 g/L), MPI # 58, 104.

5. Clear Water Repellant:

a. Clear Finish

1) 1st Coat: Coronado Texcrete Silicone Water Repellant 194 (21 g/L), MPI # 117, LEED Credit.
2) 2nd Coat: Coronado Texcrete Silicone Water Repellant 194 (21 g/L), MPI # 117, LEED Credit.

C. CONCRETE: Concrete Floors (non-vehicular), Patios, Porches, Steps and Platforms.

1. Acrylic System Water-Based:

a. Floor Finish:

1) 1st Coat: Benjamin Moore Floor & Patio Latex Enamel Low Sheen N122 (45 g/L), LEED 2009.
2) 2nd Coat: Benjamin Moore Floor & Patio Latex Enamel Low Sheen N122 (45 g/L), LEED 2009.

D. METAL: Aluminum, Galvanized.

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L) MPI # 11.
2) 2nd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L) MPI # 11.

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Ultra Spec HP Acrylic DTM Semi-Gloss Enamel HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.
2) 2nd Coat: Benjamin Moore Ultra Spec HP Acrylic DTM Semi-Gloss Enamel HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009.

c. Satin Finish:
1) 1st Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.
2) 2nd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.

d. Flat Finish:
1) 1st Coat: Benjamin Moore Ultra Spec Exterior Flat Finish N447 (45 g/L), MPI # 10.
2) 2nd Coat: Benjamin Moore Ultra Spec Exterior Flat Finish N447 (45 g/L), MPI # 10.

E. METAL: Misc. Iron, Ornamental Iron, Structural Iron and Steel, Ferrous Metal.
1. Latex Systems:
a. Gloss Finish
1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L) MPI # 11.
3) 3rd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L) MPI # 11.
b. Semi-Gloss Finish
1) 1st Coat: Corotech Acrylic Metal Primer V110 (199 g/L), LEED Credit.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

F. WOOD: Decks, Exterior including pressure treated lumber, Floors (non-Vehicular), Platforms.

1. Acrylic Water-Based Floor System:

a. Floor Finish:

1) 1st Coat: Benjamin Moore Fresh Start Multi-Purpose Primer N023 (44 g/L), MPI # 6, 17, X-Green 17, 39, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Floor & Patio Latex Enamel Low Sheen N122 (45 g/L), LEED 2009.

2. Stain Systems:

a. Solid Color Acrylic Latex:

1) 1st Coat: Benjamin Moore Arborcoat Solid Deck & Siding Stain 640 (93 g/L), MPI # 16.
2) 2nd Coat: Benjamin Moore Arborcoat Solid Deck & Siding Stain 640 (93 g/L), MPI # 16.

b. Semi-Transparent Stain:

1) 1st Coat: Benjamin Moore Arborcoat Semi-Transparent Deck & Siding Stain N638 (92 g/L), MPI # 156.
2) 2nd Coat: Benjamin Moore Arborcoat Semi-Transparent Deck & Siding Stain N638 (92 g/L), MPI # 156.

c. Clear Stain:

1) 1st Coat: Benjamin Moore Arborcoat Waterproofer 320 (34 g/L).

G. WOOD: Siding, Trim, Shutters, Sashes, Hardboard-Bare/Primed.

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L), MPI # 11.
3) 3rd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L), MPI # 11.

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

c. Satin Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.
3) 3rd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.

d. Flat Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec Exterior Flat Finish N447 (45 g/L), MPI # 10.
3) 3rd Coat: Benjamin Moore Ultra Spec Exterior Flat Finish N447 (45 g/L), MPI # 10.
4) 3rd Coat: Benjamin Moore Regal Select Exterior High-Build Flat Finish N400 (42 g/L) MPI # 10.

2. Stain - Water Reducible Systems:

a. Semi-Transparent:

1) 1st Coat: Benjamin Moore Arborcoat Semi-Transparent Deck & Siding Stain N638 (92 g/L) MPI # 156.
2) 2nd Coat: Benjamin Moore Arborcoat Semi-Transparent Deck & Siding Stain N638 (92 g/L) MPI # 156.

b. Solid Color:

1) 1st Coat: Benjamin Moore Arborcoat Solid Deck & Siding Stain 640 (93 g/L) MPI # 16.
2) 2nd Coat: Benjamin Moore Arborcoat Solid Deck & Siding Stain 640 (93 g/L) MPI # 16.

H. ARCHITECTURAL PVC, PLASTIC, FIBERGLASS

1. Latex Systems:

    a. Gloss Finish:

        1) 1st Coat: Insl-X Stix Waterborne Bonding Primer SXA-110 (47 g/L).
        2) 2nd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L) MPI # 11.
        3) 3rd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L) MPI # 11.

    b. Semi-Gloss:

        1) 1st Coat: Insl-X Stix Waterborne Bonding Primer SXA-110 (47 g/L).
        2) 2nd Coat: Benjamin Moore Ben Waterborne Exterior Soft-Gloss 543 (45 g/L), MPI # 11.
        3) 3rd Coat: Benjamin Moore Ben Waterborne Exterior Soft-Gloss 543 (45 g/L), MPI # 11.

    c. Satin Finish:

        1) 1st Coat: Insl-X Stix Waterborne Bonding Primer SXA-110 (47 g/L).
        2) 2nd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.
        3) 3rd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.

    d. Flat Finish:

        1) 1st Coat: Insl-X Stix Waterborne Bonding Primer SXA-110 (47 g/L).
        2) 2nd Coat: Benjamin Moore Ultra Spec Exterior Flat Finish N447 (45 g/L), MPI # 10.
        3) 3rd Coat: Benjamin Moore Ultra Spec Exterior Flat Finish N447 (45 g/L), MPI # 10.

I. DRYWALL: Gypsum Board, Exterior Drywall.

1. Latex Systems:

    a. Gloss Finish:

        1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
        2) 2nd Coat: Benjamin Moore Ben Waterborne Exterior Soft-Gloss 543 (45 g/L), MPI # 11.
        3) 3rd Coat: Benjamin Moore Ben Waterborne Exterior Soft-Gloss 543 (45 g/L), MPI # 11.

    b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.
3) 3rd Coat: Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss Enamel, HP29 (45 g/L), MPI # 141, X-Green 141, 153, X-Green 153, LEED 2009, LEED V4.

c. Satin Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore ben Exterior Low Luster 542 (45 g/l), MPI # 15.
3) 3rd Coat: Benjamin Moore ben Exterior Low Luster (45 g/l), MPI # 15.

d. Flat Finish:

1) 1st Coat: Benjamin Moore Fresh Start High-Hiding All Purpose Primer 046 (44 g/L), MPI # 6, 17, X-Green 17, 39, 50, X-Green 50, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore ben Waterborne Exterior Flat 541 (44 g/L), MPI # 10.
3) 3rd Coat: Benjamin Moore ben Waterborne Exterior Flat 541 (44 g/L), MPI # 10.

J. VINYL SIDING EIFS, SYNTHETIC STUCCO:

1. Latex Systems:

a. Gloss Finish:

1) 1st Coat: Benjamin Moore Fresh Start Multi-Purpose Primer N023 (44 g/L), MPI # 6, 17, X-Green 17, 39, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L) MPI # 11.
3) 3rd Coat: Benjamin Moore Ultra Spec EXT Gloss Finish N449 (46 g/L) MPI # 11.

b. Semi-Gloss Finish:

1) 1st Coat: Benjamin Moore Regal Select Exterior High-Build Soft-Gloss N403 (43 g/L), MPI # 11, 311.
2) 2nd Coat: Benjamin Moore Regal Select Exterior High-Build Soft-Gloss N403 (43 g/L), MPI # 11, 311.

c. Satin Finish:

1) 1st Coat: Benjamin Moore Fresh Start Multi-Purpose Primer N023 (44 g/L), MPI # 6, 17, X-Green 17, 39, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.
3) 3rd Coat: Benjamin Moore Ultra Spec EXT Satin N448 (46 g/L), MPI # 15.

d. Flat Finish:

1) 1st Coat: Benjamin Moore Fresh Start Multi-Purpose Primer N023 (44 g/L), MPI # 6, 17, X-Green 17, 39, 137, X-Green 137, LEED Credit, CHPS Certified.
2) 2nd Coat: Benjamin Moore Ultra Spec Exterior Flat Finish N447 (45 g/L), MPI # 10.
3) 3rd Coat: Benjamin Moore Ultra Spec Exterior Flat Finish N447 (45 g/L), MPI # 10.

PART 3 EXECUTION

3.1 EXAMINATION

A. The Contractor shall review the product manufacturer's special instructions for surface preparation, application, temperature, re-coat times, and product limitations.

B. The Contractor shall review product health and safety precautions listed by the manufacturer.

C. The Contractor shall be responsible for enforcing on site health and safety requirements associated with the Work.

D. Do not begin installation until substrates have been properly prepared.

E. Ensure that surfaces to receive paint are dry immediately prior to application.

F. Ensure that moisture-retaining substrates to receive paint have moisture content within tolerances allowed by coating manufacturer. Where exceeding the following values, promptly notify Architect and obtain direction before beginning work.

1. Concrete and Masonry: 3-5 percent. Allow new concrete to cure a minimum of 28 days.
2. Exterior Wood: 17 percent.
3. Interior Wood: 15 percent.
4. Interior Finish Detail Woodwork, Including Trim, and Casework: 10 percent.
5. Plaster and Gypsum: 15 percent.
6. Concrete Slab-On-Grade: Perform calcium chloride test over 24 hour period or other acceptable test to manufacturer. Verify acceptable moisture transmission and pH levels.

G. Examine surfaces to receive coatings for surface imperfections and contaminants that could impair performance or appearance of coatings, including but not limited to,

loose primer, rust, scale, oil, grease, mildew, algae, or fungus, stains or marks, cracks, indentations, or abrasions.

H. Correct conditions that could impair performance or appearance of coatings in accordance with specified surface preparation procedures before proceeding with coating application.

3.2 PREPARATION - GENERAL

A. Clean surfaces thoroughly prior to coating application.

B. Do not start work until surfaces to be finished are in proper condition to produce finished surfaces of uniform, satisfactory appearance.

C. Stains and Marks: Remove completely, if possible, using materials and methods recommended by coating manufacturer; cover stains and marks which cannot be completely removed with isolating primer or sealer recommended by coating manufacturer to prevent bleed-through.

D. Remove Mildew, Algae, and Fungus using materials and methods recommended by coating manufacturer.

E. Remove dust and loose particulate matter from surfaces to receive coatings immediately prior to coating application.

F. Remove or protect adjacent hardware, electrical equipment plates, mechanical grilles and louvers, lighting fixture trim, and other items not indicated to receive coatings.

G. Move or protect equipment and fixtures adjacent to surfaces indicated to receive coatings to allow application of coatings.

H. Protect adjacent surfaces not indicated to receive coatings.

I. Prepare surfaces in accordance with manufacturer's instructions for specified coatings and indicated materials, using only methods and materials recommended by coating manufacturer.

3.3 SURFACE PREPARATION

A. Concrete and Concrete Masonry: Clean surfaces free of loose particles, sand, efflorescence, laitance, form oil, curing compounds, and other substances which could impair coating performance or appearance.

B. Concrete Floors: Remove contaminants which could impair coating performance or appearance. Verify moisture transmission and alkaline-acid balance recommended by coating manufacturer; mechanically abrade surface to achieve 80-100 grit medium-sandpaper texture.

C. Existing Coatings:

1. Remove surface irregularities by scraping or sanding to produce uniform substrate for coating application; apply one coat primer of type recommended by coating manufacturer for maximum coating adhesion.

2. If presence of lead in existing coatings is suspected, cease surface preparation and notify Architect immediately.

D. Gypsum Board: Repair cracks, holes and other surface defects with joint compound to produce surface flush with adjacent surfaces.

E. Masonry Surfaces - Restored: Remove loose particles, sand, efflorescence, laitance, cleaning compounds and other substances that could impair coating performance or appearance.

F. Metals - Aluminum, Mill-Finish: Clean and etch surfaces with a phosphoric acid-water solution or water based industrial cleaner. Flush with clean water and allow to dry, before applying primer coat.

G. Metals - Copper: Clean surfaces with pressurized steam, pressurized water, or solvent washing.

H. Metals - Ferrous, Unprimed: Remove rust or scale, if present, by wire brush cleaning, power tool cleaning, or sandblast cleaning; remove grease, oil, and other contaminants which could impair coating performance or appearance by solvent cleaning, with phosphoric-acid solution cleaning of welds, bolts and nuts; spot-prime repaired welds with specified primer.

I. Metals - Ferrous, Shop-Primed: Remove loose primer and rust, if present, by scraping and sanding, feathering edges of cleaned areas to produce uniform flat surface; solvent-clean surfaces and spot-prime bare metal with specified primer, feathering edges to produce uniform flat surface.

J. Metals - Galvanized Steel (not passivated): Clean with a water-based industrial strength cleaner, apply an adhesion promoter followed by a clean water rinse. Alternately, wipe down surfaces using clean, lint-free cloths saturated with xylene or lacquer thinner; followed by wiping the surface dry using clean, lint-free cloths.

K. Metals - Galvanized Steel, Passivated: Clean with water-based industrial strength cleaner. After the surface has been prepared, apply recommended primer to a small area. Allow primer to cure for 7 days, and test adhesion using the "cross-hatch adhesion tape test" method in accordance with ASTM D 3359. If the adhesion of the primer is positive, proceed with a recommended coating system for galvanized metal.

L. Metals - Stainless Steel: Clean surfaces with pressurized steam, pressurized water, or water-based industrial cleaner.

M. Plaster: Repair cracks, holes and other surface defects as required to maintain proper surface adhesion. Apply patching plaster or Joint compound and sand to produce surface flush with adjacent undamaged surface. Allow a full cure prior to coating application as recommended by the patching compound manufacturer's recommendations.

N. Polyvinyl Chloride (PVC) Pipe: remove contaminants and markings with denatured alcohol scuff sand and wipe with solvent for maximum adhesion. Test adhesion before starting the job.

O. Fiberglass Doors - remove contaminants with cleaning solvent (alcohol) scuff sand and wipe. Test adhesion of primer before starting job.

P. Textiles - Insulated Coverings, Canvas or Cotton: Clean using high-pressure air and solvent of type recommended for material.

Q. Wood:

1. Seal knots, pitch streaks, and sap areas with sealer recommended by coating manufacturer; fill nail recesses and cracks with filler recommended by coating manufacturer; sand surfaces smooth.
2. Remove mill marks and ink stamped grade marks.
3. Apply primer coat to back of wood trim and paneling.

R. Wood Doors: Seal door tops and bottoms prior to finishing.

S. Wood Doors - Field-Glazed Frames and Sash: Prime or seal glazing channels prior to glazing.

3.4 APPLICATION - GENERAL

A. Application of primers, paints, stains or coatings, by the Contractor, will serve as acceptance that surfaces were properly prepared in accordance with the manufacturer's recommendation.

B. Apply each coat to uniform coating thickness in accordance with manufacturer's instructions, not exceeding manufacturer's specified maximum spread rate for indicated surface; thins, brush marks, roller marks, orange-peel, or other application imperfections are not permitted.

C. Allow manufacturer's specified drying time, and ensure correct coating adhesion, for each coat before applying next coat.

D. Inspect each coat before applying next coat; touch-up surface imperfections with coating material, feathering, and sanding if required; touch-up areas to achieve flat, uniform surface without surface defects visible from 5 feet (1.5 m).

E. Remove dust and other foreign materials from substrate immediately prior to applying each coat.

F. Where paint application abuts other materials or other coating color, terminate coating with a clean sharp termination line without coating overlap.

G. Where color changes occur between adjoining spaces, through framed openings that are of same color as adjoining surfaces, change color at outside stop corner nearest to face of closed door.

H. Re-prepare and re-coat unsatisfactory finishes; refinish entire area to corners or other natural terminations.

3.5 CLEANING

A. Clean excess coating materials, and coating materials deposited on surfaces not indicated to receive coatings, as construction activities of this section progress; do not allow to dry.

B. Re-install hardware, electrical equipment plates, mechanical grilles and louvers, lighting fixture trim, and other items that have been removed to protect from contact with coatings.

C. Reconnect equipment adjacent to surfaces indicated to receive coatings.

D. Relocate to original position equipment and fixtures that have been moved to allow application of coatings.

E. Remove protective materials.

3.6 PROTECTION AND REPAIR

A. Protect completed coating applications from damage by subsequent construction activities.

B. Repair to Architect's acceptance coatings damaged by subsequent construction activities. Where repairs cannot be made to Architect's acceptance, re-apply finish coating to nearest adjacent change of surface plane, in both horizontal and vertical directions.

END OF SECTION

SECTION 09 96 00 - HIGH-PERFORMANCE COATINGS

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. This Section includes surface preparation and field application of high-performance coating systems to items and surfaces scheduled.

B. Related Sections include the following:

1. Division 5 Section "Structural Steel" for shop priming structural steel.

1.3 DEFINITIONS

A. Standard coating terms defined in ASTM D 16 apply to this Section.

B. SSPC - The Society for Protective Coatings.

C. NACE - National Association of Corrosion Engineers.

1.4 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Specification Sections.

B. Product Data: For each paint system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

C. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.

D. Samples for Initial Selection: For each type of topcoat product indicated.

E. Samples for Verification: For each type of coating system and in each color and gloss of topcoat indicated.

1) Submit Samples on rigid backing, 8 inches (200 mm) square.
2) Step coats on Samples to show each coat required for system.

3) Label each coat of each Sample.
4) Label each Sample for location and application area.

F. Product List: For each product indicated, include the following:

1) Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2) Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
3) VOC content.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:
1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. Handling instructions and precautions.
9. VOC Content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.

1.6 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 45 and 95 deg F, and is expected to remain between 45 and 95 deg F for at least two hours after application.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
2. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.
3. All surface preparation and painting work is performed under the protective guidelines and requirements of OSHA "Safety and Health Regulations for Construction", latest revision, as set forth in the Federal Register, and that all such

protection is the responsibility of the Contractor and shall be provided at the Contractor's expense.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated in the coating system descriptions.

B. Manufacturers' Names: The following manufacturers are referred to in the coating system descriptions by shortened versions of their names shown in parenthesis:
   1. ICI Dulux Paints; Devoe Coatings (ICI).
   2. Induron Coatings, Inc. (Induron).
   3. Tnemec Company, Inc. (Tnemec).

2.2 COATINGS MATERIALS, GENERAL

A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another, and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying manufacturer's product identification are not acceptable.

   1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification of 450 g/L or less.

D. No claim of the Contractor concerning the unsuitability of the material specified or his inability to produce first class work with the same, will be entertained, unless such claim is made in writing to the Engineers before the Contract is signed.

2.3 HIGH-PERFORMANCE COATING SYSTEMS

A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."

B. Material Compatibility:

   1. Provide materials for use within each coating system that are compatible with one another, and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
   3. Provide products of same manufacturer for each coat in a coating system.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction[**and, for interior coatings applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24)**].

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: 250 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
6. Pre-Treatment Wash Primers: 420 g/L.
7. Floor Coatings: 100 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials: Interior coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. General: Outline of coating work follows:

F. All Exposed Piping (outdoors, inside buildings, tunnels, galleries, vaults):

1. Primer
   a. ICI Devoe - Bar-Rust 231 — 3.0 – 5.0 mils DFT
   b. Induron PE 70 Epoxy Primer — 3.0 – 5.0 mils DFT
   c. Tnemec 20 Pota-poxy — 3.0 – 5.0 mils DFT

2. Intermediate Coat
   a. None
   b. Induron Perma Clean II Epoxy — 3.0 – 5.0 mils DFT
   c. Tnemec Series 66 Epoxoline — 3.0 – 5.0 mils DFT

3. Finish Coat
   a. ICI Devoe Devthane 379 (Two Coats) — 2.0 – 3.0 mils DFT(Per Coat)
   b. Induron Indurethane 6600 Plus — 2.0 – 3.0 mils DFT
   c. Tnemec Series 1094 Endura-Shield — 2.0 – 3.0 mils DFT

G. All Metal Work, Shapes, Beams, Columns, Motors, Pumps, Equipment, Gear Motors, Valves, Valve Stands, Valve Operators and Similar Items (except where items are immersed in liquid):

1. Primer
   a. ICI Devoe - Bar-Rust 231 — 3.0 – 5.0 mils DFT
   b. Induron PE 70 Epoxy Primer — 3.0 – 5.0 mils DFT
   c. Tnemec 20 Pota-pox — 3.0 – 5.0 mils DFT

2. Intermediate Coat
   a. None
   b. Induron Perma-Clean II Epoxy — 3.0 – 5.0 mils DFT

c. Tnemec 66 Epoxoline 3.0 – 5.0 mils DFT

3. Finish Coat
   a. ICI Devoe Devthane 379 (Two Coat) 2.0 – 3.0 mils DFT (per coat)
   b. Induron Indurethane 6600 Plus 2.0 – 3.0 mils DFT
   c. Tnemec 1094 Endura-Shield 2.0 – 3.0 mils DFT

H. Valves, Shafting, Guides, Brackets, Gates, Piping Immersed in Liquid (coated to 1'0" above liquid level:

1. Primer
   a. Induron PE 70 Epoxy Primer 2.0 – 3.0 mils DFT
   b. Tnemec 20 Pota-Pox 4.0 – 6.0 mils DFT

2. Intermediate Coat
   a. Induron – none required
   b. Tnemec – non required

3. Finish Coat
   a. Induron TL 70 10.0 – 15.0 mils DFT
   b. Tnemec 141 Epoxoline 10.0 – 15.0 mils DFT

I. Equipment, Beams, Drive bases and Similar Equipment exposed over basins and at greater than 1'0" above liquid level:

1. Primer
   a. Induron PE 70 Epoxy Primer 3.0 – 5.0 mils DFT
   b. Tnemec 20 Pota-Pox 3.0 – 5.0 mils DFT

2. Intermediate Coat
   a. Induron Perma Clean II Epoxy 3.0 – 5.0 mils DFT
   b. Tnemec 66 Epoxoline 3.0 – 5.0 mils DFT

3. Finish Coat
   a. Induron Indurethane 6600 Plus 2.0 – 3.0 mils DFT
   b. Tnemec 1094 Endura-Shield 2.0 – 3.0 mils DFT

J. Guard chains, supports and brackets not immersed in liquid and other miscellaneous ironwork items specified to be galvanized shall not be painted.

K. Certain items such as control center sections, control cubicles and panel boards are specified to be furnished with baked-on enamel or other factory finish, and shall not be painted. Should finish of these items, however, be scarred or otherwise damaged, the items shall be touched up if possible or completely refinished, as required by the Engineer.

L. Brass, bronze, copper and aluminum or equipment components fabricated from these materials shall not be painted.

M. Where surfaces are specified to be coated with coal tar epoxy, total dry film thickness of coating shall not be less than 16 mils.

2.4 COLORS

A. Tnemec colors and codes shall be used as a basis for Color Coding. The color code establishes, defines, and assigns a definite color for each category of pipe, pipelines, equipment, or other items that are not listed in the Color Coding Schedule shall be assigned a color by the Engineer and shall be treated as an integral part of the Contract.

B. Banding for pipes shall be as specified in the Color Coding Schedule. Bands shall be 2-in wide and spaced 5-ft on center, located on each end of the pipe title, at 2-ft from the label bands, and at wall penetrations.

C. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange #CA26.

D. All safety equipment shall be painted in accordance with OSHA standards.

E. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to but not including the flanges attached to pumps and mechanical equipment assigned another color. Tanks shall be painted the color of the piping system that they serve, unless the tank is fiberglass and levels are monitored through the tank.

F. All conduit shall be painted to match its background surface.

G. Control panels shall be factory finished.

H. All colors will be confirmed by the Engineer from color charts submitted by the Contractor, based on the color coding schedule herein.

2.5 COLOR IDENTIFIFCATION

A. All color numbers and names herein refer to master color card. Colors of specified equal manufacturers may be substituted with approval of the Engineer.

B. Building finishes shall be painted as scheduled in the Architectural finish schedule.

C. The following Tnemec colors shall be used as a basis for the Color Coding Schedule:

COLORS	TENEMAC NAME	TENEMIC #
White	White	11WH
Ivory	Bone	08BR
Tan	Longhorn	13BR
Safety Orange	Tangerine Orange	04SF
Orange	International Orange	05SF
Yellow	Bright Yellow	03SF
Safety Yellow	Lemon Yellow	02SF
Safety Green	Spearmint Green	09SF
Dark Green	Hunter Green	08SF
Olive Green	Clover	110GN
Light Green	Irish Spring	37GN

Light Brown	Twine	68BR
Dark Brown	Weathered Bark	84BR
Safety Red	Candy Apple Red	06SF
Light Gray	Slate Gray	31GR
Dark Red	Monterrey Tile	28RD
Medium Gray	Gray	33GR
Dark Gray	Deep Space	34GR
Blue Gray	Midnight Gray	14GR
Safety Blue	True Blue	11SF
Light Blue	Fountain Blue	25BL
Medium Blue	Mediterranean Blue	34BL
Dark Blue	Academy Blue	35BL
Aqua	Aqua Sky	10GN
Blue Green	Merlin	06GN
Dark Bronze	Dark Bronze	86BR
Magenta	Cinder Cone	07GR

2.6 COLOR CODING SCHEDULE

A. The Color Coding Schedule included in Table 1, at the end of this Section, is intended to identify all potential piping and establish a color selection for each based on industry standards. This project may not necessarily incorporate all piping listed, and the Owner may require a different color schedule. The final color schedule will be determined by the Engineer and confirmed by the Owner at the time of shop drawing review. The Contractor shall submit standard color charts for color selections.

B. Other Colors, if not identified in appropriate Specification Sections, shall be selected by the Engineer and approved by the Owner.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall have on the project site the following testing equipment. Equipment shall be in calibration and proper working order. Equipment shall be used in accordance with the manufacturers' instructions or as directed by the Engineer. The Engineer shall be notified of time of testing so that he might be present to witness testing.

1. Sling Psychrometer: Relative humidity and dew point readings shall be taken at intervals throughout the day’s work. Readings shall be taken at the start of the mornings work, mid-day and afternoon. Should environmental conditions change, additional reading shall be taken to assure that coatings are being applied under the conditions as outlined by the coating’s manufacturer.

2. Surface Temperature Thermometer: Surface temperatures shall be taken in areas where work is being performed. Surface temperature shall be that as specified by the coating’s manufacturer.

3. Replica Tape & Micrometer Testex X-Course Replica Tape shall be employed to determine the surface profile of blasted surfaces. Surface profile shall be as specified.

4. Dry Film Thickness Measurements: Dry film thickness reading shall be taken with a properly calibrated (per the manufacturer's instructions) Type 1 (magnetic) or Type 2 (electromagnetic) instrument. Dry film thickness reading will be taken and recorded in the in a frequency and manner as dictated by the Engineer.

3.2 EXAMINATION

A. With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.

1. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.
2. Start of application is construed as Applicator's acceptance of surfaces within that particular area.

B. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

   a. Confirmation of primer's suitability for expected service conditions.
   b. Confirmation of primer's ability to be top coated with materials specified.

2. Notify Engineer about anticipated problems before using the coatings specified over substrates primed by others.

3.3 PREPARATION

A. General: Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

B. Cleaning: Before applying high-performance coatings, clean substrates of substances that could impair bond of coatings.

1. Remove oil and grease before cleaning per SSPC-SP1 solvent cleaning.
2. Schedule cleaning and coating application so dust and other contaminates from cleaning process will not fall on wet, newly coated surfaces or contaminate previously cleaned surfaces.
3. Sprinkle floors to lay the dust if necessary, to prevent dust from falling on wet paint.

C. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove primers and reprime substrate.

2. Ferrous-Metal Substrates: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances per SSPC-SP1 solvent cleaning

    a. Blast-clean steel surfaces as recommended by coating manufacturer and according to SSPC-SP 10 Near White Blast Cleaning.
    b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire brush, solvent clean, and touch up with same primer as the shop coat.
    c. Steel surfaces not to be immersed in liquid shall receive one coat of rust-inhibitive epoxy primer.

        1) Such surfaces shall be prepared for shop coating in accordance with Commercial Blast Cleaning (SSPC-SP6).
        2) After receipt of such components, surfaces of components shall be prepared for finish painting by wire brushing (SSPC-SP2) or by brush-off blasting (SSPC-SP7).

    d. Cast or ductile iron surfaces not to be immersed in liquid shall be prepared for painting by wire brushing (SSPC-SP2) or by brush-off blasting (SSPC-SP7). Where cast or ductile iron items are received on the job with a prime coat, cleaning shall be as specified hereinabove, and patch-coat shall be applied as required.

        1) Patch coat and finish coats shall be compatible with prime coat. Where cast or ductile iron items (such as motor housings, stands and similar items) are received on the job with finish coats already applied, cleaning shall be in accordance with The Society for Protective Coatings (SSPC) Specifications SSPC-SP1, SSPC-SP2, SSPC-SP7, as required.
        2) Wash primer coat and finish coat shall be applied in accordance with the color schedule selected by the Owner; and shall be compatible with the factory finish.

D. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
3. Use only the type of thinners approved by manufacturer and only within recommended limits.

4. All thinner shall be added to the paint upon activation. No thinner will be allowed to be added to activated paint to prevent hardening or curing of project prior to application.

3.4 APPLICATION

A. General: Apply high-performance coatings according to manufacturer's written instructions., unless Engineer specifically authorize the contractor, in writing, to modify the procedure outlined in the manufacturer's instructions.

1. Use applicators and techniques best suited for the material being applied.
2. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
3. Provide finish coats compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, grilles, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.

    a. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
    b. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

5. All paints and coatings shall be applied by qualified workmen, experienced in the application of particular type of paint or coating used.

    a. Workmen shall exercise extreme care to protect all painted surfaces and/or those prepared for painting.
    b. It shall be the Contractor's responsibility to prevent damage to any structures, vehicles, vegetation, etc., that might be affected by transmittal of solvent, or coating droplets, or mist, by wind or other means during the performance of the work outlined herein.
    c. All workmanship shall be of the very best, with all materials evenly spread and smoothly flowed on without runs or sagging.

B. Finish paint coat shall not be applied to the structural parts of equipment, motors drives and similar items until such equipment has been erected, installed, tested and adjusted under service conditions.

C. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration. Additional coats shall be required to achieve the specified Dry Film Thickness.

1. The number of coats and film thickness required is the same regardless of application method.

    a. Omit primer on metal surfaces that have been shop primed and touch-up painted.
    b. Do not apply succeeding coats until previous coat has cured as

recommended by manufacturer.

c. Where manufacturer's written instructions require sanding, sand between applications to produce a smooth, even surface.

d. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until coating has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat does not cause undercoat to lift or lose adhesion.

2. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.

D. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.

b. Brush out and work brush coats into surfaces in an even film.

c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.

E. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

1. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

G. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.5 FIELD QUALITY CONTROL

A. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove

rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

B. Paints approved for various surfaces shall be as manufactured by companies listed above. The manufacturer shall make available to the Contractor the services of a technical representative who shall be consulted with respect to drying times, cure-out times, compatibility of primers and overcoats, and miscellaneous problems that might arise during the progress of the work.

C. The Contractor shall properly prepare surfaces prior to proceeding with work and shall be held responsible for any poor work caused by improperly prepared surfaces. The application of the first coat of paint by the Contractor shall be construed as an acceptance by him of the responsibility for the condition of the base.

D. After the new coatings have been in service for a period longer than six months, but less than twelve months, the Owner will make arrangements for an inspection of the coatings, both interior and exterior.

1. The Contractor shall have a representative present for the inspection and shall be prepared to perform any minor corrective work at the time of inspection.

3.6 CLEANING

A. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.7 PROTECTION

A. The Contractor is solely responsible for protecting all existing surfaces, structures, and other facilities adjacent to or in the vicinity of the surfaces being coated, whether above or below ground. The Contractor must furnish, install and maintain all necessary protective measures in order to prevent overspray and/or other damage from occurring. The Contractor shall repair and/or pay for all damages resulting from his operations or personnel to existing facilities, and shall settle in full all damage suites which may arise as a result of his operations.

B. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Engineer, and leave in an undamaged condition.

1. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.
2. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces to original condition, or replace with new. Comply with procedures specified in PDCA P1.

COLOR CODING SCHEDULE

PROCESS	COLOR CODING DESCRIPTION	COLORS[1]		
		PIPE	BANDING	LABEL
Raw Influent	Olive Green	110GN Clover	None	White
Sewer (Sanitary, Filtrate or Other)	Dark Gray	34GR Deep Space	None	White
Backwash Piping	Light Brown	68BR Twine	None	Black
Process Drains	Dark Gray	34GR Deep Space	None	White
Sludge	Dark Brown	84BR Weathered Bark	None	White
Plant Water	Light Blue	25BL Fountain Blue	None	Black
Reuse Water	Purple	16SR Rec water Purple	None	Black
Potable Water	Dark Blue	38BL Academy Blue	None	White
Blower (Process) Air	White	10HT White	None	Black
Compressed Air/Instrument Air	Aluminum	57GR Aluminum	None	Black
Plumbing Drains & Vents	Black	35GR Black	None	White
Alum or Primary Coagulant	Orange	04SF Tangerine Orange/Safety	None	Black
Ammonia	White	10HT White	None	Black
Carbon Slurry	Black	35GR Black	None	White
Caustic	Yellow/ Green Band	02SF Lemon Yellow/Safety	09SF Spearmint Green/Safety	Black
Chlorine (Gas)	Yellow	02SF Lemon Yellow/Safety	None	Black
Chlorine (Solution)	Yellow/ Blue Band	02SF Lemon Yellow/Safety	11SF True Blue/Safety	Black
Ferric Chloride	Orange/ Blue Band	04SF Tangerine Orange/Safety	11SF True Blue/Safety	Black
Flouride	Light Blue/ Red Band	25BL Fountainbleu	06SF Candy Apple Red/Safety	White
Lime Slurry	Light Green	37GN Irish Spring	None	Black
Ozone	Yellow/ Orange Band	02SF Lemon Yellow/Safety	04SF Tangerine Orange/Safety	Black

PROCESS	COLOR CODING DESCRIPTION	COLORS[1]		
		PIPE	BANDING	LABEL
Phosphate Compounds	Light Green/ Red Band	37GN Irish Spring	06SF Candy Apple Red/Safety	Black
Polymers/Coagulant Aids	Purple	14SF Purple Rain/Safety	None	White
Soda Ash	Light Green/ Orange Band	37GN Irish Spring	04SF Tangerine Orange/Safety	White
Ferric Chloride	Orange/ Dark Blue Band	04SF Safety Orange	11SF Safety Blue	Black
Sulfur Dioxide	Yellow/ Red Band	02SF Lemon Yellow/Safety	06SF Candy Apple Red/Safety	Black
Acid Drains	Black with Yellow Band	35GR Black	02SF Lemon Yellow/Safety	White
Fuel Oil or Diesel	Red with White Band	06SF Candy Apple Red/Safety	10HT White	White
Natural Gas	Dark Red with Black Band	14YW Canary Yellow	None	Black
Sludge Gas	Dark Red	28RD Monterrey Tile	None	White
Nitrogen Gas	Green with Blue Band	09SF Spearmint Green/Safety	11SF True Blue/Safety	White
Electrical	Light Gray	32GR Light Gray	None	Black
Hoists/Trolleys	Yellow	03SF Bright Yellow	None	White

Notes:
[1] Tnemec colors are used as the basis for this Schedule.

END OF SECTION 09 96 00

SECTION 133419 - METAL BUILDING SYSTEMS

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. Structural-steel framing.
   2. Metal roof panels.
   3. Metal wall panels.
   4. Metal soffit panels.
   5. Thermal insulation.
   6. Accessories.

B. Related Sections:
   1. Division 8 Openings
   2. Division 3 Section Concrete

1.3 DEFINITIONS

A. Bay Spacing: Dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured perpendicular to end wall (outside face of end-wall girt).

B. Building Length: Dimension of the building measured perpendicular to main framing from end wall to end wall (outside face of girt to outside face of girt).

C. Building Width: Dimension of building measured parallel to main framing from sidewall to sidewall (outside face of girt to outside face of girt).

D. Clear Span: Distance between supports of beams, girders, or trusses (measured from the lowest level of connecting area of a column and a rafter frame, or knee).

E. Eave Height: Vertical dimension from the finished floor to eave (the line along the sidewall formed by the intersection of the planes of the roof

F. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SUBMITTALS

A. Product Data: For each type of metal building system component. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

1. Structural-steel-framing system.
2. Metal roof panels.
3. Metal wall panels.
4. Metal soffit panels.
5. Insulation and vapor retarder facings.
6. Flashing and trim.
7. Accessories.
8. Gutters and Downspouts

B. Shop Drawings: For the following metal building system components. Include plans, elevations, sections, details, and attachments to other work.

1. For installed components indicated to comply with design loads, include structural analysis data signed by the qualified engineer, registered in the State of Georgia, responsible for their preparation.
2. Anchor-Bolt Plans: Submit anchor-bolt plans and templates before foundation work begins. Include location, diameter, and projection of anchor bolts required to attach metal building to foundation. Indicate column reactions at each location.
3. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.
4. Metal Roof and Wall Panel Layout Drawings: Show layouts of metal panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.
    a. Show wall-mounted items including doors, windows, louvers, and lighting fixtures.
5. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches :
    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.

C. Samples for Initial Selection: Manufacturer’s color charts showing the full range of colors for each type of the following products with factory-applied color finish.

D. Qualification Data: For qualified Firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects, and addresses of architects and owners.

E. Welding certificates. Copies of certificates for welding procedures and personnel.

F. Metal Building System Certificates: For each type of metal building system, from manufacturer. Signed by the manufacturer's certifying that products comply with requirements. Include evidence of manufacturing experience and sealed by qualified professional engineer registered in the State of Georgia. Include the following:

a. Name and location of Project.
b. Order number.
c. Name of manufacturer.
d. Name of Contractor.
e. Building dimensions including width, length, height, and roof slope.
f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
g. Governing building code and year of edition used in design.
h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category.
i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
j. Building-Use Category: Indicate category of building use and its effect on load importance factors.
k. AISC Certification for Category MB or IAS Certification: Include statement that metal building system and components were designed and produced in an AISC-Certified Facility or an IAS Certified facility by an AISC-Certified Manufacturer or an IAS Certified Manufacturer.

G. Erector Certificates: For each product, from manufacturer. Signed by manufacturer certifying that erectors comply with requirements.
1. Manufacturer Certificates: For each product, from manufacturer.
2. Thermal insulation.

H. Maintenance Data: For metal panel finishes to include in maintenance manuals.

I. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide a metal building system manufactured by a firm experienced in manufacturing metal building systems that are similar to those indicated for this project and have a record of successful in-service performance and are qualified manufacturer and member of MBMA or IAS.

1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.
2. IAS Certification for Metal Buildings
3. Engineering Responsibility: Preparation of Shop Drawings, testing program development, test result interpretation and comprehensive engineering analysis by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing

engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal building systems that are similar to those indicated for this Project in material, design and extent.

C. Erector Qualifications: Engage an experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is certified in writing by the metal building manufacturer as qualified for the erection of the manufacturer's products.

D. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

E. Single - Source Responsibility: Obtain metal building system components, including primary and secondary framing, metal panel assemblies, and accessory components from single source from single manufacturer.

F. Product Options: Information on Drawings and Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject or verifications by one or more methods including preconstruction testing, field testing or in-service performance. Do not modify intended aesthetic effects, as judged by the architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

G. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

H. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings," for design requirements and allowable stresses.

I. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

J. Pre-installation Conference: Conduct conference at Project site. Attendees list to include (minimum) owner's representative, Georgia Building Commission inspector, architect, general contractor's project manager, general contractor's project superintendent, metal building manufacturer's representative and metal building erector's representative. Review methods and procedures related to metal building systems.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:

a. Condition of foundations and other preparatory work performed by other trades.
b. Structural load limitations.

c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver prefabricated components, sheets, panels, and other manufactured items so they will not be damaged or deformed. Package metal wall and roof panels for protection during transportation and handling.

B. Handling: Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weather tight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect plastic insulation as follows:
1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver -plastic insulation materials to Project site before installation time.
3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify metal building system foundations on the contract drawings and by field measurements before metal building fabrication and indicate measurements on shop drawings.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Concrete."

B. Coordinate installation of roof penetrations, which are specified in Division 07 Section "Roof Accessories."

C. Coordinate fabrications schedule with construction schedule to avoid delaying the work.

D. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak proof, secure, and noncorrosive installation.

1.9 WARRANTY

A. General Warranty: Special warranties 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 Contract Documents.

B. Special Project Guarantee: Submit three executed copies of the "Roofing Guarantee" (ABC Form 13-a, Rev. 11/90) included at the end of this Section, signed and countersigned by Installer (Roofer) and Contractor, guaranteeing work of this Section, including roofing membrane, composition flashing, roof insulation, and roofing accessories, against leaks from faulty or defective materials and workmanship for a period of five (5) years from the date of substantial completion. This guarantee is in addition to the Manufacturer's Warranty required below.

C. Special Warranty on Panels: Written warranty, executed by manufacturer agreeing to repair or replace roof or wall panels that fail in materials or workmanship within specified warranty period.

D. Warranty Period: Five years from the date of Substantial Completion.

E. Special Warranty on Metal Panel Finishes: Written warranty, signed by manufacturer agreeing to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period. Deterioration of finish includes but is not limited to, color fade, chalking, cracking, peeling, and loss of film integrity.
1. Finish Warranty Period: 20 years from date of Substantial Completion.

F. Special Weather tightness Warranty for Standing-Seam Metal Roof Panels: Written warranty, signed by manufacturer agreeing to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weather tight within specified warranty period. This Special Warranty is to be a "Full Value Warranty" with third party inspection prior to issuance of Special Warranty, and shall include coverage for replacement of materials and all required labor for full warranty period.

G. Warranty Period: 20 years from date of Substantial Completion.

H. Roofing warranties or guarantees which contain language regarding the governing of the warranties or guarantees by any other state other than the State of Georgia, must be amended to exclude such language and substituting the requirements that the Laws of the State of Georgia shall govern all such warranties or guarantees.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
   1. American Buildings Company; Division of Magnatrax Corp.
   2. Bigbee Steel Buildings, Inc.
   3. Ceco Building Systems; Division of NCI Building Systems, L.P.
   4. Gulf States Manufacturers, Inc.; Division of Magnatrax Corp.
   5. Star Building Systems; an NCI company.
   6. Varco – Pruden Buildings
   7. Kirby – A Nucor Company
   8. Cheyenne Mountain Steel, LLC

B. Other manufacturers may be submitted subject to compliance with this specification and the Owner’s approval.

2.2 METAL BUILDING SYSTEMS

A. General Description: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing, roof, wall panels, and accessories complying with requirements indicated, including those is this article.

B. Metal Buildings System Design: Provide metal building system of size and with bay spacings, roof slopes, and spans indicated.

   a. Primary-Frame Type: Rigid Clear Span: Solid-member, structural-framing system without interior columns.
   b. No fixed base columns.

C. End-Wall Framing: Provide Manufacturer's standard framing, load-bearing end-wall and corner columns and rafters.

D. Secondary-Frame Type: Manufacturer's standard rafters and partially inset-framed girts.

E. Eave Height: as indicated by nominal height on Drawings.

F. Bay Spacing: As indicated on the drawings.

G. Roof Slope: As indicated on the drawings.

H. Roof System: Manufacturer's standard standing seam metal roof panels with field-installed insulation.

I. Exterior Wall System: Manufacturer's standard field-assembled wall panels with field-installed insulation.

2.3 METAL BUILDING SYSTEM PERFORMANCE

A. Structural Performance: Provide metal building systems capable to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual or IAS standards."

1. Design Loads: Basic design loads, as well as collateral loads are to be in accordance with the International Building Code latest edition as modified for the particular geographical area. Building structure shall be designed to meet required loads as erected from factory without field modification of primary framing. Metal Building Systems Manufacturer is to include Design Loads used with his submittals.
2. Design Load shall include all equipment/utilities supported from Metal Building System.

B. Seismic Performance: Design and engineer metal building systems capable of withstanding the effects of earthquake motions determined according to the building code in effect for this Project of ASCE 7 “Minimum Design Loads for buildings and Other Structures” Section 9, Earthquake Loads,“ whichever is more stringent.

C. Thermal Movements: Provide metal building roof and wall panel systems 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 calculations 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.

D. Air Infiltration for Roof Panels: Provide roof panel assemblies with permanent resistance to air leakage through assembly of not more than 0.09 cfm/sq. Ft. of fixed roof area when tested according to ASTM E 1680 at a static-air-pressure difference of 4 lbs/Sq. Ft.

E. Air Infiltration for Wall Panels: Provide wall panel assemblies with permanent resistance to air leakage through assembly of not more than 0.090 cfm/sq.Ft. of wall area when tested according to ASTM E 283 at static-air-pressure difference of 4 lbs/sq. Ft.

F. Water Penetration for Roof Panels: Provide roof panel assemblies with no water penetration when tested according to ASTM E 1646 at a minimum differential test-pressure difference of 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. Ft. (300 Pa) and not more than 12 lbf/sq. Ft. (575 Pa).

G. Water Penetration for Wall Panels: Provide wall panel assemblies with no water penetration when tested according to ASTM E 331 at a minimum differential pressure of

20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. Ft. (300 Pa) and not more than 12 lbf/sq. Ft. (575 Pa)

H. Retain first paragraph below if UL class roof is not required. Verify that products are listed in UL's "Roofing Materials and Systems Directory"

I. Thermal Performance: Provide insulated metal panel assemblies with the following maximum U-factors and minimum R-values for opaque elements when tested according to ASTM C 1363 or ASTM C 518:

1. Metal Roof Panel Assemblies:
   a. R-Value: 19
2. Metal Wall Panel Assemblies:
   a. R-Value: 19

2.4 STRUCTURAL-STEEL FRAMING

A. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafter, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.
2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
3. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.
4. Frame Configuration: Single gable or as indicated on the drawings.
5. Exterior Column Type: Uniform depth.
6. Rafter Type: Uniform depth.

B. End-Wall Framing: Provide the following primary end wall framing members fabricated for field-bolted assembly:

1. End-Wall and Corner Columns: Manufacturer's standard shop-painted, built-up factory- welded I-shaped or cold-formed C-shaped sections fabricated from 14-gage (0.0747-inch) steel. End-Wall Rafters: Manufacturer's standard shop-painted C-shaped, cold-formed, structural-steel sheet fabricated from 16-gage (0.0598-inch) Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, pre-painted with coil coating, to comply with the following:
2. Purlins: Z-shaped sections; fabricated from 16 gage thick (0.0598 inch) built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- wide flanges.
   a. Depth: As needed to comply with system performance requirements.

3. Girts: Z-shaped sections; fabricated from 16 gage (0.0598 inch) thick built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 45 to 50 degrees from flange, and with minimum 2-1/2-inch-wide flanges.
    a. Depth: As required to comply with system performance requirements.

4. Eave Struts: Unequal-flange, C-shaped sections; formed to provide adequate backup for both wall and roof panels. Fabricate from 16 gage (0.0598-inch) thick steel sheet, built –up plates or structural-steel shapes; to provide adequate backup for metal panels.
5. Flange and Sag Bracing: Minimum 1-5/8” x 1-5/8” structural-steel angles or 1-inch diameter, cold-formed structural tubing to stiffen primary-frame flanges fabricated from 16-gage (0.0598-inch) shop painted roll-formed steel.
6. Base or Sill Angles: Fabricate from 14-gage (0.0747-inch) cold-formed galvanized steel sections.
7. Purlin and Girt Clips: Clips shall be fabricated from 14 –gage (0.0747-inch) zinc coated steel sheet. Secondary End-Wall Framing: Structural members, except columns and beams, shall be the manufacturer's standard sections fabricated from 14-gage (0.0747-inch) cold-formed shop painted steel.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.

C. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.

    1. Type: as indicated.

D. Wind Bracing: Provide portal frames or rods or cables for wind bracing. Portal frame bracing will be required for the southern bays of the Solids Storage canopy to allow clearance for heavy equipment access.

E. Bolts: Provide shop-painted bolts except when structural-framing components are in direct contact with roof and wall panels. Provide zinc-plated or cadmium-plated bolts when structural-framing components are in direct contact with roof and wall panels.

F. Retain and revise first paragraph below to suit Project.

G. Materials:

    1. Structural Steel Shapes: Comply with ASTM A 36/A 36M or A529/A 529M.
    2. Steel Plate, Bar or Strip: Provide 55,000 psi minimum yield stress and 70,000 psi minimum tensile strength. Comply with ASTM A 529 /A 529M, ASTM A 570/A 570M or ASTM A 572/A 572M.
    3. Steel Tubing or Pipe: Comply with ASTM A 500, Grade B, ASTM A, 501 or ASTM A 53, Grade B.
    4. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B structural tubing.

5. Structural Quality Zinc-Coated Steel Sheet: Comply with ASTM A 446 with G90 coating complying with ASTM A 525. Material to comply with ASTM A 653/A 653M, Grade 80. Retain first subparagraph below for secondary framing if required.
6. Structural Quality Aluminum-Zinc Alloy Steel Sheet: Comply with requirements of ASTM A 792/A 792M.
7. Bolts for Structural Framing: Comply with ASTM A 307 or ASTM A 325 as necessary for design loads and connection details.

H. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil.
   a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil on each side.
2. Prime galvanized members with specified primer after phosphoric acid pretreatment.
3. Primer: SSPC-Paint 15, Type I, red oxide.

2.5 METAL ROOF PANELS

A. Vertical-Rib, Standing-Seam Metal Roof Panels: Manufacturer's standard factory-formed standing seam roof panel system designed for mechanical attachment of panels to roof purlins using concealed fasteners and sealants. Form panels of 24 gage (0.0239-inch), Grade C, aluminum-zinc alloy coated steel sheets. Panels shall have a configuration consisting of 2 inch high by major rib, space at 24 inches on centers. Panels are joined at side laps with an interlocking standing seam 1 inch above the major rib. Each panel provides 18 inch net coverage in width. The female panel seam shall have a factory applied sealant.

1. Material: Aluminum-zinc alloy-coated steel sheet. 0.028-inch
   a. Exterior Finish: Fluoropolymer.
2. Color: As selected by Architect from manufacturer's full range. (Minimum of 8 color choices)
3. Roof Panel Accessories: Provide components required for a complete roof panel's assembly including trim, copings, fascia, mullions, sills, corner units, ridge closures, clips seam covers, battens, flashings, gutters, downspouts, sealants, gaskets, fillers, closure strips, and similar items. Match materials and finishes of roof panels unless otherwise indicated.
   a. Clips: Provide 16-gage (0.0598-inch) panel clips. floating type to accommodate thermal movement ; fabricated from zinc-coated (galvanized) steel
   b. Cleats: Factory-caulked, mechanically seamed cleats formed from 24-gage (0.0239-inch), Grade C, zinc-coated steel sheets.
   c. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets, self-locking bolts, end – welded studs and other suitable fasteners designed to withstand design loads.

d. Provide metal-backed neoprene washers under heads of fasteners bearing on weather side of panels.
e. Use aluminum or stainless steel fasteners for exterior application and galvanized or cadminum-plated fasteners for interior applications.
f. Locate and space fastenings in true vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of neoprene washer.
g. Provide fasteners with heads matching color of roofing or siding sheets by means of plastic caps or factory-applied coating.
h. Flexible Closure Strips: Closed-cell, expanded cellular rubber, self-extinguishing flexible closure strips. Cur or pre-mold to match configuration of roofing and siding sheets. Provide closure strips where indicated or necessary to ensure weather-tight construction.
i. Sealing Tape: Pressure-sensitive 100 percent solids grey polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, non-staining tape ½" wide and 1/8" inch thick.

4. Joint Type: Mechanically seamed, folded according to manufacturer's standard.

5. Panel Coverage: 18 inches .

6. Panel Height: 2 inches .

7. Uplift Rating: UL 90.

B. Materials:

1. Metallic-Coated Steel Sheet: Restricted-flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 50; structural quality.
   b. Surface: Smooth, flat finish.

C. Finishes:

1. Exposed Coil-Coated Finish:
   a. Two-Coat Fluoropolymer: AAMA 621. Panel finish shall be a two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight, with a total minimum dry film thickness or 1 mil (0.025 mm) and 30 percent reflective gloss when tested according to ASTM D 523. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.6 METAL WALL PANELS

A. Exterior Wall Panels: Manufacturer's standard factory-formed ribbed panels fabricated from 24 gage (0.028 inch) aluminum-zinc alloy coated steel sheets pre-painted with coil coating to provide 36-inch wide (914 mm) coverage, with 1-1/4" raised ribs at 12 inches (305 mm) o.c., and intermediate stiffening ribs symmetrically spaced between major ribs for full length of panel. Design panels for mechanical attachment to structure with exposed fasteners, in color to match prefinished wall panels, lapping major ribs at panel edges. There shall be a purlin bearing leg on the bottom section of the lap.

B. Reverse-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with recessed, trapezoidal major valleys and intermediate stiffening valleys symmetrically spaced between major valleys; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch nominal thickness.
   a. Exterior Finish: Fluoropolymer.
   b. Color: As selected by Architect from manufacturer's full range.
2. Major-Rib Spacing: 12 inches o.c.
3. Panel Coverage: 36 inches.
4. Panel Height: 1.25 inches.

C. Tapered-Rib-Profile, Metal Liner Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch nominal thickness.
   a. Exterior Finish: Siliconized polyester
   b. Color: As selected by Architect from manufacturer's full range.
2. Major-Rib Spacing: 12 inches o.c.
3. Panel Coverage: 36 inches.
4. Panel Height: 1.25 inches.

D. Materials:

1. Metallic-Coated Steel Sheet: Restricted-flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Aluminum-Zinc Alloy-Coated Steel SheetSurface: Smooth, flat finish.

E. Finishes:

1. Exposed Coil-Coated Finish:
   a. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat. Use for interior.

F. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

G. Wall Panel Accessories: Provide components required for a complete wall panel assembly, including trim, copings, mullions, sills, corner units, clips, seam covers, battens, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match materials and finishes of panels.

2.7 METAL SOFFIT PANELS

A. General: Provide factory-formed 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 weather tight installation.

B. Tapered-Rib-Profile, Exposed-Fastener Metal Soffit Panels: Formed with raised, trapezoidal major ribs and flat pan between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch nominal thickness.
   a. Exterior Finish: Fluoropolymer.
   b. Color: As selected by Architect from manufacturer's full range.
2. Major-Rib Spacing: 12 inches o.c.
3. Panel Height: 0.75 inch.

C. Concealed-Fastener Metal Soffit Panels: Formed with vertical panel edges and flush surface; with flush joint between panels; with 1-inch- wide flange for attaching interior finish; 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.

1. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch nominal thickness.
   a. Exterior Finish: Fluoropolymer.
   b. Color: As selected by Architect from manufacturer's full range.
2. Panel Coverage: 12 inches.
3. Panel Height: 7/8”.

2.8 THERMAL INSULATION

A. Faced Metal Building Insulation: ASTM C 991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch- wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

   a. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm when tested according to ASTM E 96/E 96M, Desiccant Method.
   b. Basis of Design: Lamtec Corporation “GymGuard.” Equal products by API Group Inc. or Alpha Associates Group Inc.
   c. Composition: White metallized polypropylene film facing and fiberglass-polyester-blend fabric backing.
   d. Weight: 75 lbs/ 3000 square feet
   e. Puncture Resistance : 650 Beach Units

f. Caliper / Thickness: 0.007 inch

B. Mesh Grid Insulation Protection: A knotted mesh on a nominal 2-3/4” by 2-3/4” grid. The mesh is made from twisted twine of DuPont nylon Type 6-6 fiber. The mesh covering interior bays is made from #21 twine. The mesh covering end bays is made from #21 twine except a 6’ strip along the edge which is made from #30 twine. This edge shall be color coded for identification. The mesh has a double selvage along the two edges in the machine direction. The #21 twine and the #30 twine used to make the mesh shall have a minimum tensile strength of 205 pounds and 265 pounds, respectively. The #21 twine shall have a runnage of 960 feet per pound and the #30 twine shall have a runnage of 605 feet per pound. The cord used to make the mesh to mesh edge connections shall be #36 DuPont nylon, type 6-6 white braided twine. It shall have a minimum tensile strength of 350 pounds and a runnage of 533 feet per pound.

C. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.9 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

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.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, 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 material as metal roof panels.
2. Clips: Manufacturer's standard, formed from steel sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from steel sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. 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 weather tight construction.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
2. 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 wall panel profile. Provide closure strips where indicated or necessary to ensure weather tight construction.

D. Flashing and Trim: Formed from 24 gage nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match adjacent metal panels.

1. 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.
2. Opening Trim: Formed from 24 gage nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

E. Gutters: Formed from 24 gage nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized according to SMACNA's "Architectural Sheet Metal Manual." Finish gutters to match roof fascia and rake trim.

1. Gutter Supports: Fabricated from same material and finish as gutters spaced 36” o.c.
2. Strainers: Provide Bronze, copper, or aluminum wire ball type at outlets.
3. All exterior gutters and downspouts shall be designed for a minimum rainfall intensity based upon a 5-year recurrence interval for a five-minute duration. All interior gutters, valleys and downspouts shall be designed for a minimum rainfall intensity based upon a 25-year recurrence interval based on a five-minute duration.

F. Downspouts: Formed from 26 gage nominal-thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- long sections, complete with formed elbows and offsets. Finish downspouts to match wall panels. Provide in size and shape required for roof area.

1. Mounting Straps: Fabricated from same material and finish as gutters.
2. Continuous or Sectional-Ridge Type: Factory-engineered and -fabricated, continuous unit; fabricated from 24 gage nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal roof panels. Fabricated in minimum 10-foot- long sections. Provide throat size and total length indicated, complete with side baffles, ventilator assembly, end caps, splice plates, and reinforcing diaphragms.
    a. Bird Screening: Galvanized steel, 1/2-inch- square mesh, 0.041-inch wire; or aluminum, 1/2-inch- square mesh, 0.063-inch wire.

b. Throat Size: 9 or 12 inches, as standard with manufacturer, and as required to comply with ventilation requirements.

G. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
   a. Fasteners for Roof and Wall Panels: Self-drilling or self-tapping Type 410 stainless-steel, or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.
   b. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
   c. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

2.10 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly and disassembly.

1. Fabricate components in such a manner that once assembled, they may be disassembled, repackaged, and res-assembled with a minimum amount of labor.
2. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
3. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop-fabricate framing components to indicated size and section, with base plates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly. Straight columns required.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing members.
5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication to a minimum dry film thickness of 1 mil (0.025mm).

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll-forming or break-forming, with base plates, bearing plates, stiffeners, and other

plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication to a minimum film thickness of 1 mil (0.025mm).

E. Tolerances: Comply with MBMA's "Low rise building System manual": chapter IV, Section 9, "Fabrication and Erection Tolerances."

F. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

G. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

H. FINISHES GENERAL

I. Comply with NAAMM's "Metal finishes manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

J. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half 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 assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

B. Clean substrates of oil, grease, rolling compounds, incompatible primers, and loose mill scale that impair bond of erection materials.

C. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erector must be certified in writing by the metal building manufacturer as capable of erection of the metal buildings in accordance with all the requirements of these specifications and drawings.

B. Erect metal building system according to manufacturer's written erection instructions and erection drawings.

C. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

D. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

E. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surfaces of base plates and bearing plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow curing. Comply with manufacturer's written installation instructions for proprietary grout materials.

F. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

G. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level base plates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use non-shrinking grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for bolt type and joint type specified.
    a. Joint Type: Snug tightened or pretensioned. Tighten bolts by turn-of-the-nut method.

H. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing, using clips with field connections using non-high strength bolts. Secure purlins and girts to structural framing and hold rigidly to a straight line by sag rods.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Secure purlins and girts to structural framing and hold rigidly to a straight line by sag rods.
4. Locate canopy framing as indicated.
5. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge when possible, unless otherwise indicated or restricted by shipping limitations.

1. Install ridge and hip caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten roof panels to purlins with concealed clips at each standing-seam joint. Install clips over top of insulation at location and spacing determined by manufacturer. Install clips to supports with self-drilling screws. Apply a continuous ribbon of sealant tape to clean dry surface of the weather side of fastening on end laps, and on side laps as needed to make roof sheets weatherproof to driving rains.

1. Field cutting by torch is not permitted.
2. Install screw fasteners with power tools having controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

3. Install clips to supports with self-drilling or self-tapping fasteners.
4. Install pressure plates at locations indicated in manufacturer's written installation instructions.
5. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
6. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels for fasteners.

C. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels 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.

3.5 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, where possible, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. When two rows of metal panels are required, lap panels 4 inches minimum.
4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
5. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Pre-drill panels.
6. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
7. Install screw fasteners with power tools having controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads or panels. Install screws in predrilled holes.
8. Install flashing and trim as metal wall panel work proceeds.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated; or, if not indicated, as necessary for waterproofing.
10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
12. Field cutting by torch is not permitted.

B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.

C. Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint using concealed clip and fasteners at maximum 42 inches o.c., spaced not more than manufacturer's recommendation. Fully engage tongue and groove of adjacent insulated metal wall panels.

1. Install clips to supports with self-tapping fasteners.
2. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels as weather seal.

D. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet, noncumulative, on level, plumb, and on location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 METAL SOFFIT PANEL INSTALLATION

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.7 THERMAL INSULATION INSTALLATION

A. General: Install insulation concurrently with metal panel installation, according to manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.
3. Fiberglass Blanket Insulation: Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.
4. At wall panels, install insulation over girts in accordance with manufacturer’s standard procedures.
5. At roof panels, install insulation over purlins in accordance with manufacturer’s standard procedures.

B. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.8 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weather tight mounting, and provide for thermal expansion. Coordinate installation with door and louver manufacturer and 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.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide for thermal expansion of metal units; conceal fasteners when 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. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

E. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.9 ADJUSTING

A. Roof Ventilators: After completing installation, including work by other trades, lubricate, test, and adjust units to operate easily and be free of warp, twist, or distortion as needed to provide fully functioning units.

1. Adjust louver blades to be weather tight when in closed position.

3.10 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting: After erection, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

D. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

E. Metal Panels: Remove temporary protective coverings and strippable films, if any, as soon as each metal panel is installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 13 34 19

SECTION 22 05 19 - FLOW METERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Parshall Flume Flow Meters
2. Magnetic Flow Meters

1.2 SUBMITTALS

A. Product Data: Provide product data for flow meters and performance characteristics for each flow meter.

B. Submit written confirmation that each manufacturer has reviewed all of the rate-of-flow controller requirements and that each piece of equipment is compatible with the other and that each piece of equipment is suitable for the intended design conditions.

C. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Prepare all equipment for shipping as follows:

1. Protect internal and external parts against rust and corrosion.
2. Keep sealed and protected from moisture and store indoors.

1.4 WARRANTY

A. Warranty Period: One year from date of Substantial Completion. Warranty shall be for unlimited usage of the equipment for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Parshall Flumes

1. Tracom
2. Plastifab
3. Approved Equivalent

B. Magnetic Flow Meters

1. ABB
2. Foxboro
3. Siemens

2.2 PARSHALL FLUMES

A. Each flume shall be a molded structure of fiberglass reinforced polyester. The interior surface shall have a ten (10) to fifteen (15) mil white ultraviolet-resistant gel-coat backed by a rich layer of resin and chopped glass forming a water and chemical resistant surface. The remainder of the laminate shall be fiberglass reinforced polyester containing not less than thirty percent (30%) glass content by weight.

B. The minimum thickness of the walls and floor of the flume shall not be less than one-fourth inch (¼"); and shall be reinforced with stiffeners down the sides and across the bottom on flumes with a throat width of three inches (3") or greater. The stiffeners shall be joined together at the knee to form a rigid dimensionally stable flume.

C. The flume shall be provided with pultruded FRP anchoring clips fastened along the side of the flume to be used for anchorage into the concrete. Stiffeners made of FRP angle/channel shall be provided across the top of the flume to provide structural support during shipping and installation.

D. Flume dimensions shall be in accordance with the United States Department of Interior, Water Measurement Manual, latest revision. The manufacturer shall have a documented, ongoing quality control program.

E. Each flume shall be provided with a head gauge molded into the side of the flume, calibrated in (tenths-hundredths of a foot and MGD). A two position stainless steel ultrasonic mounting bracket shall also be provided, at the point of measurement as indicated on the plans.

F. Inlet and/or outlet adapters shall be included to provide transition between pipes and the flumes, as applicable. Inlet and outlet pipe stubs, of the size shown on the Plans, shall be included as necessary to provide a transition between pipes and the flumes. Where flumes are mounted in channels, inlet and outlet bulkheads or wingwalls shall be included to provide a means of flow transition between the flume and the channel.

2.3 MAGNETIC FLOW METERS

A. Magnetic flowmeters shall be of the low frequency electromagnetic induction type and shall produce a pulsed DC signal directly proportional to and linear with the liquid flowrate. The meter shall be designed for operation on 120 Vac ± 10%, 60 Hz ± 5% with a power consumption of less than 23 VA for sizes through 24-inch. The magnetic flowmeters shall be Siemens, Foxboro, ABB. No other manufacturer will be accepted unless listed on the Proposal Form and selected by the Owner.

B. The metering tubes shall be constructed of steel or stainless steel. All magnetic flowmeters shall be designed to mount directly in the pipe between ANSI Class 150 flanges through 24-inch. Meters shall have composite elastomer liners and 316 stainless steel electrodes. The meters shall be sized in accordance with the flow ranges required. All flow tubes shall be supplied with either grounding rings or grounding electrodes.

C. The signal converter portion of the magnetic flowmeter shall include both a magnet driver to power the magnet coils and the signal converter electronics. The signal converter shall be integrally or remotely mounted as required. It shall be housed in a NEMA 4X enclosure. When remotely mounted, the interconnecting cable shall be supplied with the meter. Signal converters shall be identical and interchangeable for all meter sizes. When integrally mounted the converter shall include a separate customer connection section to isolate the electronics compartment and protect the electronics from the environment. A separate terminal strip for power connection shall be supplied.

D. The electronics shall be of the solid state, feedback type, utilize integrated circuitry and be microprocessor controlled. All operational parameters shall be user configurable locally via an integral keypad or via a remote intelligent terminal. All changes to the data base shall be by entry of numerical values i.e., the range setting, or selectable from a menu i.e., the range units. When in the configuration mode, normal meter output shall be maintained.

E. The converter shall be provided with a back lighted, alphanumeric display for easy reading of flow and configuration data. The display shall have three rows of 20 alpha-numeric characters. For operation, the top row shall indicate instantaneous flowrate in percent or direct engineering units, field selectable. The second row shall display accumulated total flow. For configuration adjustment and system monitoring all data base parameters and error messages shall appear in the display in plain English language. Error messages shall announce incorrect entry values which will be rejected by the converter.

F. Converter failure shall be announced in the display as an error message. In addition, an alarm contact shall provide for an external indication of failure. The range setting of the signal converter shall be continuously adjustable between 5% and 100% of meter capacity. The range and other parameter adjustments shall be direct reading via the integral digital display. The converter shall have input impedance of 10^{12} ohms or greater and not be affected by quadrature noise. It shall require no zero adjustment or special tools for startup. Input and output signals shall be fully isolated. The converter output shall be 4 to 20 mAdc into 0 to 750 ohms. The unit shall be capable of

accommodating either unidirectional or bidirectional flow. The converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure.

G. There shall be supplied a 24 Vdc scaled pulse output for remote totalization. Data link communications shall also be optionally available. The converter shall be capable of communicating via an RS232C or RS485 interface using either custom Binary, custom ASCII or HART protocols. The entire data base of the converter shall be addressable and configurable through a remote intelligent terminal such as an IBM-PC compatible personal computer running appropriate communication software or hand held configurator.

H. The signal converter software shall include a noise reduction algorithm to minimize the effects of noise generating processes.

I. The signal converter shall have a self test feature for checking operational modes and alarms. Continuous diagnostics shall also be performed including, but not limited to the monitoring of electrode reference voltage to sense meter coil failure. Sensing of meter failure shall activate a user configurable output signal and a failure alarm contact closure.

J. The meter shall be hydraulically calibrated at a facility located in the United States and the calibration shall be traceable to the NIST. A computer printout of the actual calibration data giving indicated versus actual flows at a minimum of three (3) flow rates shall be provided with the meter. The calibration factor for all meters of the same size shall be a constant. The accuracy of the metering system shall be 1/2% of rate from 4 to 100% of flow for flow velocities of 1.5 to 33.33 feet per second.

K. Complete zero stability shall be an inherent characteristic of the meter system. This shall eliminate the need to zero adjust the system with a full pipe at zero flow.

L. The meter housing shall be NEMA 4X. The meter shall be capable of accidental submergence in up to 30 feet of water for up to 48 hours without damage to the electronics or interruption of the flow measurement. The meter shall be protected against corrosion.

M. Grounding rings are required (instead of grounding electrodes) to be furnished for pipe which is lined (cement lining, epoxy, etc.).

N. Cal-Master Certification Software/Hardware:

1. Insitu-Calibration Verification: This system shall be able to verify in a quantifiable manner the meters current conditions versus the meters condition when originally manufactured. This calibration verification of the meter shall be performed without need for physical access to the meter flow tube. The calibration verification shall meet or exceed the following requirements:

    a. The original FINGERPRINT values shall be stored on a computer disk given to the owner.
    b. The verification process shall consist of at least 52-meter conditions pertaining to the primary coils, electrodes, interconnecting cable and signal converter.

c. The coil verification shall include faults of continuity, impedance, and resistance to ground, inductance, and magnetic field strength.
d. The electrode verification shall include faults of continuity, impedance and insulation.
e. The cable verification shall include faults of coil, electrode, driven shield, and ground connections, cable cuts, cable damage, and water in the cable.
f. Signal converter verification shall include faults of current supply to coils, zero offset, span forward and reverse, electrode offset, current output, frequency output forward and reverse, driven shield to ground, overall shield to ground and signal ground connection to ground.
g. The calibration verification shall include the following: water ingress into the primary elements, faulty electrodes, dirty electrodes, electrode leakage, corroded electrodes, high process noise, liner failure, conductive coatings on the liner, insulating coatings on the liner, and primary element damage.
h. All tests shall be performed by means of comparison between the absolute values and change in values from the new conditions.
i. Verification standard shall be ±1% of wet calibration for meters produced using the calibration verification service, or ±2% for standard meters.
j. The software shall be windows based. This software shall be capable of generating a report based upon the result of the forgoing described tests. The software shall be capable of creating and storing an audit trail of the meters conditions and the meters history.
k. The calibration verification and metering system shall meet or exceed the standards established by the National Testing Laboratories.

2. Meters to be designed, manufactured, and calibrated in an ISO9001, NAMAS, NIST, NATA certified facility.
3. Contractor shall provide all required Cal-Master software, interface modules and communication cables between laptop computers and converters to perform above procedures.
4. Manufacturer shall provide minimum three days training and instruction on the use of all software and hardware. Certified factory technicians shall perform all training.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment and installation area for compliance with requirements for installation tolerances and other conditions affecting performance

B. Examine controller for cleanliness, freedom from foreign matter, and corrosion.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer’s detailed written instructions for installing equipment.

B. Performance Test:

1. The Contractor and manufacturer shall conduct a performance test on each

installed flow meter.

2. The performance test shall determine the flowrate through the meter as a function of the flow control valve position over the range 10 percent open to 100 percent open in 5-degree increments.
3. The data shall be presented in a table and graph for each test and submitted to the Owner.

3.3 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer, and ensure that equipment is without damage or deterioration at the time of Substantial Completion.

3.4 START-UP ASSISTANCE AND TRAINING

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below:

1. A factory authorized service representative (for each system and/or piece of equipment) from the manufacturer shall perform all necessary on-site assistance and installation supervision.
2. Once the flow meters and/or rate-of-flow controllers have been installed correctly and are operating as intended, the service representative(s) shall perform eight (8) hours of on-site start-up assistance/operator training.
3. Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventive maintenance.
4. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 22 05 19

SECTION 22 05 23 - VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:

1. Gate Valves - Water Service
2. Gate Valves - Wastewater Service
3. Bronze Gate Valves
4. Butterfly Valves
5. Plug Valves - Eccentric Type
6. Globe/Silent Check Valves
7. Swing Check Valves
8. Rubber Check Valves
9. Ball Valves
10. Telescoping Valves
11. Valve Boxes
12. Extension Stems
13. Valve Markers

1.2 SUBMITTALS

A. Product Data:

1. For each type of valve indicated include the following information:

a. Body, seating, and trim materials
b. Valve design
c. Pressure and temperature classifications
d. End connections
e. Arrangement
f. Dimensions
g. Required clearances

2. Include list indicating valve and its application.
3. Include rated capacities.
4. Include shipping, installed, and operating weights.
5. Include list of furnished specialties and accessories.
6. Include proof of hydrostatic test and proof of design test.

B. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable

speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturer's: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Gate Valves - Water Service

a. Mueller Company
b. M&H Valves and Fittings Company
c. American-Darling
d. Clow

2. Gate Valves - Wastewater Service

a. Gate Valves less than 2 inch size:
1) Jenkins
2) Powell

b. Gate Valves 2 inch size and larger:

1) Mueller Co.
2) American R/D

3) Clow

3. Bronze Gate Valves

    a. Powell
    b. Jenkins

4. Butterfly Valves

    a. Pratt
    b. DeZurik
    c. American by Val-Matic

5. Plug Valves - Eccentric Type

    a. DeZurick
    b. Keystone
    c. Milliken
    d. Val-Matic

6. Check Valves - Globe/Silent Type

    a. APCO
    b. Val-Matic
    c. Cla-val
    d. Crispin

7. Check Valves - Swing Type

    a. APCO
    b. Golden-Anderson
    c. CCNE

8. Rubber Check Valves

    a. Tide Flex Series 35 as manufactured by Red Valve

9. Ball Valves

    a. Hills-McCanna
    b. Chemetron

10. Pressure Relief Valves

    a. Model F1493 as manufactured by Clow
    b. Trumbull
    c. American R/D

11. Valve Boxes

    a. Valve boxes for 2¼" and smaller valves:

1) Opelika Foundry Company, Roadway type

b. Valve boxes for valves larger than 2¼"

1) Mueller Buffalo type
2) Opelika Foundry Company

12. Telescoping Valves

1) Troy Valve
2) Waterman USA
3) Approved equivalent

2.2 GATE VALVES (3” & Larger)

A. Gate valves, 3" and larger, shall be resilient seated solid wedge gate valves and shall be rated for 250 psig cold water working pressure, bi-directional. Valves shall meet AWWA C509 or C515.

B. Valves shall be iron body construction, full opening, non-rising stem. Stem shall be brass, bronze or stainless steel and shall have a minimum of three O-ring seals. The top seals shall be replaceable with the valve fully open and while under full operating pressure. Thrust collar and bearing surfaces shall be isolated from the waterway and provided with continuous lubrication. Alternatively, non-corrosive thrust bearings shall be furnished above and below the collar. Wedge shall be encapsulated with EPDM rubber. Bolting materials shall be 305 stainless steel.

C. Ferrous metal surfaces shall have a 12 mil, fusion bonded, NSF 61 certified coating applied in accordance with AWWA C550.

D. Valves 30” and larger in diameter for horizontal applications shall have brass stem bushings located in the bonnet, and shall have bronze rollers housed in a bronze scraper on the bottom of the wedge, traveling in a 316 SS track.

E. Operators for valves 18” and larger shall be provided. Operator shall have bevel gears (horizontal) or spur gears (vertical).

F. Valve shall be equipped with flanged or mechanical joint ends, hand wheels, operators, or operating nuts as required or indicated.

G. Each valve shall be hydrostatically tested in accordance with AWWA C515.

2.3 BRONZE GATE VALVES

A. All bronze body gate valves shall be pressure rated as shown in the piping schedules and/or as indicated but, if pressure ratings should not be given, the valves shall be rated at not less than 200 psi maximum working pressure.

B. In order to ensure an adequate safety factor valve shells shall by hydrostatically tested at not less than 350 psi.

C. Valves shall be union bonnet type, with solid wedge gate and rising stem.

D. Valves shall be all-bronze construction with exceptions of handwheel and handwheel nut. Handwheel shall be malleable iron, and handwheel nut (stem nut) shall be either brass or bronze.

E. All valves shall be provided with backseating to permit repacking the valve under full pressure when it is wide open.

F. Valves shall have ends as required for connections to threaded galvanized steel pipe, threaded alloy steel pipe (black or galvanized) or copper water tube. Where flanged connections are required, valves may be either screw-in-bonnet type or union bonnet type, according to the manufacturer's standard.

G. In general, bronze body gate valves (in size up to 3") shall be installed in galvanized steel piping, alloy steel piping or copper piping located in building vaults or galleries; and bronze body gate valves shall also be installed in copper piping located underground.

2.4 BUTTERFLY VALVES

A. Butterfly valves shall be designed, manufactured and tested in accordance with the provisions and requirements of ANSI/AWWA C504, Class 150B latest revision.

B. Valve bodies shall be constructed of cast (gray) iron ASTM A126-73 Class B, ductile iron ANSI/ASTM A536 Grade 65-45-12, or alloy cast iron ANSI-ASTM A436 Type 1 or 2, or ANSI/ASTM A439 Type D2.

C. Valve discs shall be solid construction, and shall be stainless steel as specified under the above referenced AWWA Standard or alloy cast iron ANSI/ASTM A436 Type 2.

1. Edges of discs for valves with rubber seats in the body shall be shaped, machined and polished to such configuration as will ensure smooth and even mating with the rubber seat over an acceptable angle of interference (±2½°).
2. The disc shall rotate 90° from full open position to tightly closed position, and shall be of such design as to sustain maximum differential pressure across the closed disc without exceeding a working stress of one fifth of the tensile strength of the material used in the manufacture of the disc.

D. Valve seats shall be designed so as to provide tight shut-off (droptight) at the maximum pressure differentials resulting from the working pressures specified.

1. Seating materials shall be new natural rubber or new synthetic rubber conforming to the requirements of ANSI/AWWA C504, latest revision.
2. Rubber seats shall be bonded or mechanically fastened in the valve body or disc.

E. All clamps, retaining rings and fasteners shall be stainless steel specified in the above referenced AWWA Standards.

F. Valve shafting shall be stainless steel in accordance with AWWA C504, and may be either one-piece through-body-and-disc construction, or may be stub-shaft construction.

1. Each stub-shaft shall be inserted into hubs integral with the valve disc for a distance of at least 1½ times the diameter of the shaft.
2. Lengths of hubs extending from the disc shall be such that the full required insertion can be attained.
3. The connection between the shaft and the disc shall be designed to transmit shaft torque equivalent to at least 75% of the torsional strength of the minimum shaft diameters.
4. Dowel and taper pins, if used, shall be mechanically secured.
5. All penetrations in the shaft shall be compensated for by increase in shaft diameter so that the relationship of transmitted torque to shaft torsional strength will be maintained.

G. Valve bearings shall be sleeve type, non-corrosive, and of "self-lubricated" materials. Thrust rings and/or bearings shall maintain the disc in designed centered position. Valve shafts shall be designed for connections to operators as required, and shaft seals shall be provided at capped ends and projecting ends.

H. Two external hubs for housing shaft bearings shall be integrally cast with valve bodies, and the bodies shall be equipped with mechanical joint ends, flanged ends or Victaulic ends as required.

I. All valves shall be droptight when subjected to the specified working pressure (differential pressure), and all valves shall be capable of droptight seating under bidirectional flow conditions (maximum working pressure applied as differential pressure from either direction).

J. All valve components shall be capable of withstanding water hammer shock equal to not less than 150% of pressure rating. Although the valve may leak under water hammer shock condition, after the shock has passed the valve shall return to droptight functioning without the need for any adjustment.

K. Finishes:

1. All internal ferrous metal surfaces of the valve shall have a factory applied 2-part thermo setting epoxy coating in conformance with AWWA C-550-81, or latest revision. The epoxy coating shall be FDA approved, non-toxic, taste and odor free. Surfaces shall be painted in accordance with the following Schedule:

Interior Unfinished Surfaces	Epoxy
Exterior Unfinished Surfaces of Valves to be Buried, Submerged Located in Manholes or Valve Vaults	Coal tar
Exterior Surfaces of all other valves	Rust-inhibitive primer
Polished or Machined Surfaces	Rust-preventive compound

2. Interior coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Coal Tar	6 mils
Epoxy	10 mils
Rust-Inhibitive Primer	3 mils

L. Valve Operators:

1. Valve Operators shall be traveling-nut type or geared type designed to withstand 300 ft. lbs. of input torque at fully open or fully closed positions without damage to valve or operator.
2. Operator case shall be fully-enclosed type to prevent entrance of dirt or moisture, and the case shall be grease-packed.
3. Stop-limiting devices shall be provided in the operators for open and closed positions.
4. For exposed valves, the travel of the valve shall be indicated on quadrant bolted to the body.

5. Micro-switches shall be provided for transmission of signal indicating that the valve is in "open" and/or "closed" position.

M. All valves shall open "left".

N. All valves shall be cycled at the factory as required by the AWWA Standard. After the valves have been received on the job, and immediately before they are to be installed, they shall be cycled not less than five times to determine whether proper closure will be obtained. Any adjustment required to secure proper closure shall be performed by a qualified representative of the manufacturer of the valve.

2.5 PLUG VALVES - ECCENTRIC TYPE

A. Eccentric type plug valves shall be used for wastewater and sludge service.

B. Valves shall be of non-lubricated or permanently lubricated type; shall have bodies of cast iron, ASTM A126 Grade B; shall have discs or plugs of ductile iron ASTM A536 or semi-steel; and shall have corrosion resistant bearings, bushings, and journals.

C. Valve ends shall be flanged ANSI B16.1, Class 125 except when installed underground. Valves for underground service shall be equipped with mechanical joint ends.

D. Valves shall be rated at 150 psi working pressure, bi-directional.

E. Size 4" through 24" valves shall have full port opening of not less than 80% of connecting pipe area, and size 30" and larger values shall have full port opening of not less than 70% of connecting pipe area.

F. Seats:

1. Bodies in 4" and larger valves shall be furnished with a 1/8" welded overlay seat of not less than 90% pure nickel.
2. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel.
3. Screwed in seats shall not be acceptable.

G. Finishes:

1. All wetted surfaces shall be made corrosion resistant by application of coatings, fusion bonded nylon or epoxy.
2. Exterior surfaces of valves to be installed in buried installations shall receive coal tar coating, not less than 6 mils dry film thickness.
3. Exterior surfaces of valves not installed in buried locations shall receive rust-inhibitive primer, not less than 3 mils dry film thickness.

H. Valve Operators:

1. Valves shall operate from fully-closed to fully-open with 90° turn.
2. Valves shall have full port openings of not less than 82% of connecting pipe areas; and shall be equipped with indicating quadrants, pointers, adjustable stops and locks.
3. Geared operators shall be of traveling-nut type, sealed, gasketted and lubricated; and operators shall be designed to resists submergence in water to 25 ft. head pressure.
4. All valves 6 inches and greater in size (for any service) shall be equipped with worm-and-gear operators and handwheels.

2.6 CHECK VALVES - GLOBE/SILENT TYPE

A. Globe/silent check valves shall be flanged and drilled per ASME B16 with 125/150 flange bolt circles.

B. Valve body shall be ductile Iron, ASTM A536

C. Plug and Seat Ring - lead-free bronze, Alloy C87800 or C87600

D. Resilient seat shall be Buna -N Rubber. Valve seat and plug shall be replaceable in the field for ease of maintenance. Resilient seated valves shall be drip tight.

E. Valve bushing shall be lead-free bronze, alloy C95400.

F. Valve spring shall be Type 302 stainless steel.

G. Flow area through the body shall be equal to or greater than the cross-sectional are of the equivalent pipe size.

H. The exterior valve surfaces of valves shall receive rust-inhibitive primer, not less than 3 mils dry film thickness.

I. The interior of the valve shall be coated with a fusion bonded epoxy coating.

2.7 CHECK VALVES - SWING TYPE

A. The Swing Check Valve shall be of the full waterway body type, with a domed access cover and vent port.

B. The check valve shall be capable of accepting air cushion, lever and weight or lever and spring.

C. The valves shall be designed, manufactured and tested in accordance with American Water Works Association Standard ANSI/AWWA C508 and in accordance with Manufacturers Standardization Society Standard Practice MSS SP-71 or MSS SP-136.

D. The valves used in potable water service shall be certified to NSF/ANSI 61, Drinking Water System Components - Health Effects and certified to be Lead-Free in accordance with NSF/ANSI 372.

E. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

F. The Valves shall be provided with flanges drilled in accordance with ASME B16.1, Class 125 iron flanges or ASME B16.42, Class 150 for ductile iron flanges.

G. The valve body shall be full flow equal to nominal pipe diameter area at all points through the valve and shall be equipped with a threaded adjustable open stop. The body seat shall be O-ring sealed and field replaceable without removing the valve from the line. The end flanges shall contain integrally case mounting pads.

H. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content.

I. The disc shall be of one-piece construction and connected to the shaft with a disc arm and two pivot pins to provide pivot action to allow self-adjusting seating at all pressures. 14” and larger discs shall be convex shape for lift, stabilization and strength.

J. The disc seat shall be resilient with an integral O-ring type sealing surface for drop tight shut-off at high and low pressures and for easy replacement in the field without removing the valve from the line. The removable resilient seat shall be precision molded Buna-N (NBR), ASTM D2000-BG.

K. The shaft seals shall consist of V-type packing in a fixed gland with an adjustable follower designed to prevent over-compression of the packing and to meet the design parameters of the packing manufacturer.

L. Removable, slotted shims shall be provided under the follower flanges to provide for adjustment and prevent overloading of the packing.

M. Valve shall be factory equipped with a ductile iron lever and weight assembly. When the valve is closed, the lever and weight shall be located 30 degrees below horizontal.

N. The exterior valve surfaces of valves shall receive rust-inhibitive primer, not less than 3 mils dry film thickness.

O. The interior of the valve shall be coated with a fusion bonded epoxy coating.

P. Manufacturer shall demonstrate a minimum of five (5) years' experience in the manufacture of swing check valves.

2.8 RUBBER CHECK VALVES

A. Check valves for use at the termination of drain lines or outfall lines shall be flexible, butyl rubber type.

B. Valve shall have flanged construction with inlet port area 100% of the mating pipe port size. The port area shall contour down to a duckbill which shall allow passage of flow in one direction while preventing reverse flow.

2.9 BALL VALVES

A. Ball valves for chemical service shall be manufactured from rigid polyvinyl compounds conforming to ASTM Specification Designation D-1784, latest revision, Type 1 Grade 1.

B. Valves shall be suitable for 100 psi service and shall be approved by the National Sanitation Foundation.

C. Chemical Service:

1. Diaphragm valves shall have body construction of rigid polyvinyl compounds conforming to ASTM Specification Designation D-1784, latest revision, Type 1 Grade 1.
2. Diaphragms shall be either natural rubber or neoprene.
3. Valves shall be suitable for 100 psi service and shall be approved by the National Sanitation Foundation.

D. Sludge and Scum Service:

1. Diaphragm valves shall have body construction incorporating a straight bore so that area of bore is approximately equal to that of connecting piping.
2. Body shall be constructed of cast grey iron ASTM A126, Class B, or ductile iron; and body shall be lined with neoprene (Durometer A 60-65).
3. Diaphragm shall be reinforced Hycar.
4. Valves shall be handwheel operated indicating stem type.

2.10 TELESCOPING VALVES

A. Slip Tube

1. The slip tube material shall be 304 stainless steel.
2. Slip tube should be v-notch.

B. Flange

1. Slip tube gasket shall be BUNA-N and replaceable without removal of the slip tube assembly from the riser pipe, lift rod, or actuator.
2. The gasket retainer shall be stainless steel and the flange shall be cast iron, unless otherwise specified.
3. Lift rod and bail shall be stainless steel.

C. Safety Lock Operators

1. The operator shall be a non-rising stem style with a handwheel and linear position indicator, calibrated in 1/4” increments, incorporated in the stainless steel floor stand. A stainless steel traveling torque tube and stainless steel anti-rotation plate shall be incorporated to prevent the slip tube from rotating. All fasteners are to be 304 stainless steel.

2. A stainless steel traveling torque tube and stainless steel anti-rotation plate shall be incorporated to prevent the slip tube from rotating.
3. All fasteners are to be 304 stainless steel.

4. Valve Travel – 4’-0”.

2.11 VALVE BOXES

A. All buried valves, including by-pass valves on geared valves, shall be equipped with valve boxes.

B. Valve boxes shall be cast iron, screw type, with cast iron extension pieces as required to make up length of box from surface of ground to top of valve body.

C. Valve boxes shall be manufactured of cast iron in accordance with the requirements of ASTM A48, Class 35.

D. Covers shall be marked "WATER" or “WASTEWATER”, or other as required by Engineer, according to the application.

E. Finishes:

1. All parts of valve boxes, bases, and covers shall be shop coated by dipping in asphalt varnish.

2.12 EXTENSION STEMS

A. Extension stems and stem guides shall be furnished and installed where specified or where required for proper valve operation in these specifications.

B. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the valve actuator shaft. All stem connections shall be pinned.

C. At least two stem guides shall be furnished with each valve requiring stem guides. Stem guides shall be of cast iron construction, bronze bushed and adjustable in two directional Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet, whichever is smaller.

D. The top stem guide shall be designed to carry the weight of the extension stem.

E. The extension stem shall have a collar; the collar shall be pinned to the stem and shall bear against the stem thrust guide.

2.13 VALVE MARKERS

A. Valve markers shall be furnished and installed for all valves in locations other than city streets.

B. Valve markers shall be precast reinforced concrete posts, 4"x4" or 4"x5" in cross-section and 4'-0" long.

C. Markers shall be equipped with brass or aluminum discs (as for monuments or benchmarks) as monolithically in tops of the posts.

D. Discs shall be stamped "GV" for gas valves, or “BFV” for butterfly valves, or “PV” for plug valves.

E. After a post has been set, there shall be die-stamped on the face of the disc an arrow indicating the location of the valve with respect to the marker, and there shall also be stamped on the disc the measured distance of the valve from the marker.

2.14 VENT SCREENS

A. Vent pipes for vaults, wet wells, etc. shall be equipped with a wafer-style, screened cage to help prevent foreign objects from entering the vented space.

B. Screen shall consist of 2 mesh and 20 mesh hemispherical screens fused to a water-style body, self-gasketing, with an open area equal to 100% of the pipe area. Body shall be constructed of PVC with stainless steel screens.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. General

1. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
3. Locate valves for easy access and provide separate support where necessary.
4. Install valves in horizontal piping with stem at or above center of pipe.
5. Install valves in position to allow full stem movement.
6. For buried valves, contractor shall provide operator extensions as required to bring operating nut within 4 feet of finished grade.

B. Gate Valves -Water Service

1. Valves 12" in size and smaller shall be installed in vertical position with valve stems extending to within 24" of the surface of the finished ground.
2. Valves larger than 12" shall be installed in horizontal position with valve stems extending to within 24" of the surface of finished ground.
3. Top of operating nut on valve stem shall not be closer than 20" to surface of finished ground.
4. It shall be the responsibility of the Contractor to make such variations in depths of trench as necessary to secure proper bury for the valves. The Contractor will not be permitted to make a sudden or local dip in the trench that would deviate from a constant downgrade or constant upgrade to an air release valve.
5. Where depth of bury is such that the operating nut is not at the specified depth below ground surface, extension stems shall be furnished and installed by the Contractor.
6. All underground valves, mainline and by-pass, shall be equipped with valve boxes of proper size and height, complete with covers.
7. The Contractor shall be responsible for filling of the gear case with lubricants as recommended by the manufacturer; and lubricant level shall be checked and the valve operated in the presence of the Engineer before the trench is backfilled.

C. Gate Valves - Wastewater Service

1. Underground valves shall be installed in vertical position with valve stems extending to within 24 inches of the surface of the finished ground.

2. Top of operating nut shall not be closer than 20 inches to surface of finished ground.
3. It shall be the responsibility of the Contractor to make such variations in depths of trench as are necessary to secure proper bury for the valves. The Contractor will not be permitted to make a sudden or local dip in the trench that would deviate from a constant downgrade or constant upgrade to an air release valve.
4. Where depth of bury is such that the operating nut is not at the specified depth below ground surface, extension stems shall be furnished and installed by the Contractor.
5. The Contractor shall be responsible for filling of the gear cases with lubricants as recommended by the manufacturer; and lubricant levels shall be checked and the valves operated in the presence of the Engineer before the trench is backfilled.
6. All underground valves, main-line and by-pass, shall be equipped with valve boxes of proper size and height, complete with covers.
7. Valves installed in buildings, galleries, vaults and tunnels shall be equipped with handwheels, operating nuts, extension stems, floorstands, and other operating appurtenances.
8. Valves installed in locations higher than 6'-6" above finished floor or ground shall be equipped with chainwheels and galvanized chains.

D. Butterfly Valves

1. Valves installed underground shall be equipped with grease packed operators having gasketted covers to prevent entrance of moisture into case when subjected to external hydrostatic pressure of 10 psi.
2. Valves shall be operated through AWWA valve nut mounted on vertical operating shaft extending through top of gear case. Operator extension, valve box, position indicator, and cover shall be provided for each valve. Extensions and valve boxes shall be of correct length and height to suit elevation of ground surface.
3. Valves installed in locations accessible from floor or ground shall be equipped with handwheels.
4. Valves installed in locations higher than 6'-6" above finished floor or ground shall be equipped with chainwheels and chain. The last stated provisions shall apply except when valves are indicated to be operated through floorstands or benchstands located above the valves, and in such cases valves shall be equipped with enclosed operators, extension stems, floorstands (or benchstands), and indicators.
5. The valves shall be furnished complete in accordance with the requirements of Section 5 of ANSI/AWWA C504.

E. Plug Valves - Eccentric Type

1. Each valve shall be provided with operating device to suit location of valve.
2. Valves exposed shall be equipped with hand (bar) wrenches to fit operating nut.
3. Valves located in piping trenches shall be provided with extension socket wrenches of proper length so that tee-handle is 30 inches above grating of floor. Openings in gratings shall be framed (circular) with 1/8 inch bar stock of same depth as gratings; and circular stem collars (split type) shall be provided and attached to grating so as to maintain extension wrenches in vertical position.

4. Valves installed underground shall be provided with high-head extensions of proper length.
5. All valves installed at height greater than 6'-6" above finished floor shall, without regard to size of valve, be equipped with work-and-gear operators and chain wheels complete with chains.

F. Valve Boxes

1. Valve boxes shall be installed plumb, centered over operating nut, and securely positioned while backfill is placed and tamped in such a manner that plumb and concentric position will be maintained.

3.3 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 22 05 23

SECTION 22 05 25 - VALVE AND GATE ACTUATORS

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. This Section includes the following types of actuators:

1. Electric Actuators (Valves and Gates)

1.3 SUBMITTALS

A. Product Data: Provide product data for each type of actuator to be provided. Provide a schedule of actuators that lists each actuator and the corresponding valve or gate. The schedule should indicate the type, size, opening and closing speeds, description of use and/or location, sizing calculations, and other useful information for each actuator and valve or gate. A detailed list of accessories should also be provided for each actuator.

B. Electrical and SCADA system requirements

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare actuators for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Seal and secure actuators to protect from dust, moisture and damage during shipping.

B. Use the following precautions during storage:

1. Keep actuators sealed and protected from moisture.

2. Store actuators indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in a dry location.

1.5 WARRANTY

A. The equipment shall be warranted for twelve (12) months from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S

A. Manufacturer's: Subject to compliance with requirements, provide products by one of the following:

1. Rotork
2. EIM
3. Auma

2.2 ELECTRIC ACTUATORS (VALVES AND GATES)

A. The operators shall include, but shall not be limited to, the declutch lever, handwheel, motor, gearing, limit switches, torque switches, and electrical control connections shall be of the top mounted configuration. Where specified, or located in hazardous areas defined on plans, or where otherwise noted on the plans, the electric actuators shall be Factory Mutual approved Explosion Proof protection Class I, Division 1, Groups B, C and D for hazardous locations.

B. Declutching mechanism shall allow valve operation by means of permanently attached auxiliary handwheel, meeting the O.S.H.A. requirement of no more than fifty pounds (50) rim pull effort. Actuation of motor automatically returns the operator to the electric mode. Operation of the motor shall not cause the handwheel to rotate, and operation of the handwheel shall not cause the motor to rotate. Should power be returned to the motor while the handwheel is in use, the design of the unit shall prevent transmission of the motor torque to the handwheel. The handwheel shall have an arrow and the word "OPEN" indicating required rotation. The handwheel shall operate in the clockwise direction to close. External declutch lever will be padlockable in the motor mode. Actuators for sluice gates and/or gate valves larger than 48" in diameter shall be provided with an operating nut attached to the manual override drive mechanism that allows operation of the actuator in the manual mode by a powered drill or wrench operating at no more than 100 RPM.

C. All motors, gearing switches, wiring terminals and electrical connections shall be completely sealed against the environment and protected against the ingress of water, humidity, and dust. Enclosure shall be rated NEMA 4X/6. No exposed wiring or terminals shall be allowed in the switch compartment. Switches (limit and torque) shall be in IP 66 enclosure such that no dirt, dust water, etc. may interfere with the contact when limit switch compartment is removed. Actuators shall be supplied with a watertight seal between external wiring connection and the actuator housing. This seal shall prevent water ingress due to moisture penetration into conduit or external wiring connections.

D. Actuators intended for submerged applications shall be tested to IP68 standard and shall be capable of submersion to 20 feet for a period not to exceed seventy-two (72) hours.

E. Drive motor shall be designed for 460V/3PH/60Hz supply voltage and shall be of sufficient size to open or close valve against maximum differential pressure when voltage to the motor terminals is 90 percent of the nameplate rating, without loss motion considered. The motor shall be specifically designed for actuator service. Motor shall

be of the squirrel cage induction type and shall be totally enclosed, non-ventilated construction. Insulation shall be Class F, tropicalized and suitable for temperatures of up to 310 degrees F. Motor shall be of the “thermally protected” type, with three (3) thermal switches imbedded in motor windings one hundred twenty (120) degrees apart. Motor nameplate shall be in accordance with NEMA standard MGI. Motors for modulating service shall be capable of a minimum of 1,200 starts per hour.

F. All gears must meet A.G.M.A. specifications. Gearbox is to be 100% lubricant filled. To assure zero leakage, each gearbox is to be pressure tested while submerged and a visual inspection made of all seals before lubricant is installed. Gear housing shall be ductile iron or cast iron. Spur gear and worm shall be steel. Worm gear shall be bronze. Nonmetallic gears in power train are not acceptable. All gears and shafting shall be supported on anti-friction bearings. All gearing and bearings shall be grease or oil lubricated. Seals shall be provided at all exit points of the gear case to prevent leakage of lubricant.

G. Actuators with auxiliary gearing require that auxiliary gearing shall be of the wormgear type. All wormgears shall have 360 degree gearing. Gear segments are not acceptable. Mechanical stops must be adjustable from 80 to 120 degree rotation.

H. Operator is to have separate drive nut assembly with thrust bearing assembly mounted so operator may be easily mounted and removed without having to unload the valve stem, and also allow operation of the valve without operator in emergency situations. For quarter-turn applications, valve stem to gearbox mounting shall be through splined coupling of not less than 32 teeth. For multi-turn applications, attachment to the valve shall be via a mounting flange together with bronze stem nut and thrust bearings to form one (1) assembly, which is bolted to the actuator. The design of the drive system shall be such that the actuator shall be capable of removal from the valve, retaining the output drive assembly and stem nut on the valve. Emergency operation of the valve must be possible with the actuator removed.

I. Limit switches with a minimum of twelve (12) contacts rated 5A to 250VAC shall be provided for each operator (3 N.O & 3 N.C for opening and 3 N.O. & 3 N.C for closing, one pair of which shall be dry contacts available for remote voltage interrogation). Limit switch drive to be of counter gear design and shall be “in step” with the output drive at all times in both the motor drive and manual (handwheel) modes. Limit switches shall be adjustable to change state at any point between or beyond the fully open and fully closed positions, with easy set declutch. All contacts on the limit switch assembly to be sealed in minimum IP 66 enclosure to maintain the integrity of the contacts and to eliminate shorting out. Indicating lamp circuitry shall include motion assurance to indicate when the operator is in motion, and direction in which it is traveling. Motion assurance shall be wired into lamps on operator, and available for remote light circuits when specified. Position indication shall be accomplished by means of an indicator dial in full step at all times with valve travel, whether in power or manual operation. The indicator dial shall be graduated in 25% increments (closed, 25% open, 50% open, 75% open and 100% open). Limit switch gearing shall be grease lubricated. The drive mechanism shall be totally enclosed to prevent entrance of foreign matter. Metallic gears shall be used.

J. Each operator shall have a separately adjustable opening torque switch and closing torque switch. Adjustment range shall be responsive to opening or closing loads such that switches operate to protect valve and operator from damage when there is over-

torque during opening or closing. All contacts shall be sealed to insure the integrity of the contacts and to eliminate shorting out. When required, opening torque switch shall be able to control predetermined back seating thrust of a valve. Closing torque switch shall control predetermined seating thrust required for torque seating of wedge gate or globe valves. Seating torque shall be constant and independent of wear in valve disc or seat. Torque switches shall be of the SPDT, double break type with contacts rated 5A at 250VAC.

K. The actuator electrical junction box (terminal compartment) is to be completely isolated from the switch compartment and shall include the terminals for the motor leads up to 15 h.p. No separate junction box or external conduit shall be needed for the motor. Bolts shall be “captive” to prevent loss when disconnected.

L. The actuators shall be supplied with integral control housings that include reversing motor contactors, electrically and mechanically interlocked, equipped with auxiliary contacts. Contactor shall be completely wired to the complete electrical control assembly shall be contained in a minimum NEMA 4X/6 rated housing integral to the operator. Control power transformer shall be grounded with fused secondary and capable of transforming 460V, 3phase, 60 Hz to 24V DC. A minimum of three (3) threaded hubs for electrical conduit entry in controller compartment shall be provided, one (1) for primary power and two (2) for control circuits. All internal wiring in the housing shall be to terminal strips or plug assembly and all switches shall be wired to these terminals. Open-stop-close controls shall be by means of a three (3) push buttons and two (2) lights, Green for Open, Red for Closed. Local-Off-Remote control shall be by means of a three (3) position selector switch, padlockable in three positions. Auxiliary contacts shall be provided on the Local-Off-Remote selector switch to facilitate remote indication of switch position. Padlocks shall be provided for each actuator and shall be common keyed with all actuators. Actuator control packages shall be easily wall mountable remote from the actuator if required on plans. Controls packages shall be supplied with internal phase discriminator, monitor relay for collective fault signal and surge protection to 10 KV exceeding IEEE 587. An internal phase correction device shall be provided to prevent incorrect phase rotation of three phase actuators.

M. Modulating valves and gates shall meet the above requirements, and shall include solid state starters with provisions for a 4-20mA position control input signal. The position comparator circuit shall be of solid state printed circuit board design and shall include (but not be limited to) separate controls for a zero span and deadband adjustment. LED lamps shall be furnished for indication of control status and shall include as a minimum, indications for open, close and fault. One (1) watt mylar potentiometers shall be used and shall be capable of providing linearity of +/- 1% and shall be rated for up to 250 degrees F. Internal power supply shall provide regulated 24VDC power to power solid state comparator circuit (positioner) and shall have the capability to supply power to an internal, solid state 4-20 mA feedback device.

N. Actuated quarter turn valves 12” and smaller shall move from the fully open to fully closed position in 30 seconds; actuated valves larger than 14” and all valves for modulating service shall move from the fully open to fully closed position in no less than 60 seconds. Gates or valves of all sizes shall move from fully open to fully closed at a rate equal to or greater than 60 seconds per 12” of gate or valve travel.

O. If actuator floor stands are to be provided, then they shall be constructed of carbon steel or cast ductile iron sufficient to withstand the loads required to operate the actuated valve and shall be painted in accordance with the specifications. Floor stands shall be provided with permanently sealed and lubricated shaft bearing at the base of each floor stand.

P. The Contractor shall coordinate, furnish, and install all conduit, wiring, contacts and appurtenances necessary for incorporating the equipment into the SCADA system as shown and/or specified in the Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine actuators for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine actuators for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent gate movement during shipping and handling.

C. Do not attempt to repair defective actuators; replace with new actuators.

3.2 ACTUATOR INSTALLATION

A. General

1. Drawings indicate general arrangement of gates and/or actuators.
2. Comply with manufacturer's detailed written instructions for installing equipment.
3. Electrical Connections: Rough-in electrical connections according to requirements in Division 26.

3.3 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure equipment is without damage or deterioration at the time of Substantial Completion.

3.4 START-UP ASSISTANCE AND TRAINING

A. A factory-authorized service representative of the actuator manufacturer shall perform all necessary on-site assistance for actuator installation supervision and pre-startup wiring verification, and shall perform eight (8) hours of on-site start-up assistance/operator training once the equipment has been installed correctly and is operating as intended.

END OF SECTION 22 05 25

SECTION 22 05 29 - PIPE HANGERS, BRACKETS, AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes hangers and supports for mechanical system piping and equipment.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design shall allow for free expansion and contraction of piping.

C. Design shall be such that the hangers and supports cannot become disengaged by moments of the supported pipe.

D. Size and spacing of hanger rods shall be such that load carrying capacities of rods (based upon root area of thread) will not be less than 2.0 times the actual load on the hanger.

E. All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B 31.1.0, and MSS Standard Practice SP-58, except as supplemented or modified by this specification.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.

C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping shall be securely fastened, anchored, and supported by means of hangers, rods, clips, clip bases, anchor bolt inserts, brackets, rolls, roll stands, beam clamps, posts, braces, pipe stands, bases, slides and similar items as required.

B. Designs using stock or production parts shall be utilized insofar as is possible, provided that such designs are those generally accepted as exemplifying good engineering practice.

C. All rigid hangers shall provide a means of vertical adjustment after erection.

D. Pipe hangers and supports adjacent to pumps, blowers, engines and other equipment shall be so located and adjusted that equipment flanges or other connection devices will be perfectly mated before joints or connections are tightly made up.

E. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.

F. Pipe attachments for horizontal piping shall be pipe clamps, insofar as is possible.

G. Structural attachments shall be beam clamps, insofar as is practicable.

1. Where piping is supported from concrete slabs the Contractor shall furnish and install concrete inserts for attachment of hanger rods.

2. Ceiling flanges and anchor bolts may be used for attachment of hanger rods for smaller piping subject, however, to the approval of the Engineer.

H. All riser piping shall be supported independently of the horizontal piping, using riser clamps with structural attachments, base elbows or base tees.

I. All pressure piping shall be adequately braced at all points of change in direction of piping runs.

J. Pipe saddle supports and pipe stanchion saddles shall be furnished and installed where indicated on the Drawings or as required in order that piping support system will be in compliance with these Specifications.

1. Saddles and stanchion saddles shall be complete with riser pipe, flanges, and anchors.

2. Saddle and stanchion saddle units shall be adjustable when vertical adjustment is required.

K. Roll supports, rolls, roll stands, and slide assemblies shall be furnished and installed where indicated on the Drawings or as required in order that piping support system will be in compliance with these Specifications.

L. Unless otherwise specified, all fasteners, anchors, and anchor bolts shall be stainless steel.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by Grinnell Corporation, or equivalent.

2.3 MATERIALS

A. Hanger rods shall be hot rolled steel rod meeting the requirements of ASTM Specification Serial Designation A36, the latest revision.

B. Unless otherwise specified, all fasteners, anchors and anchor bolts shall be stainless steel.

PART 3 - EXECUTION

3.1 PAINTING

A. Touching Up: Clean and touch-up paint field welds, bolted connections, and abraded areas of shop paint on miscellaneous metals.

END OF SECTION 22 05 29

SECTION 22 11 13 - WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and specialties outside buildings for the following:

1. Water service meters
2. Meter boxes
3. Hose-connection, backflow prevention devices
4. Backflow preventer
5. Protective enclosures
6. Fire hydrants
7. Wall fire hydrants
8. Yard hydrants
9. Fire department connections
10. Post hydrants
11. Cross-anchor assemblies
12. Tapping sleeves and valves
13. Pipe saddles
14. Blow-off Assemblies
15. Special thrust collar and restrained bend assemblies
16. Air release valve assemblies
17. Pipeline Testing
18. Pipeline Cleaning and Disinfection
19. Service installations
20. Service transfers
21. Cased service pipe
22. Connections to existing system
23. Water systems and appurtenances

1.2 SUBMITTALS

A. Product Data: For the following:

1. Water Main Pipe
2. Piping specialties.
3. Water meters and accessories.
4. Backflow preventers and assemblies.
5. Protective enclosures.
6. Fire hydrants.
7. Yard hydrants.
8. Tapping sleeves and valves.
9. Pipe saddles.

B. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

C. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

D. NSF Compliance: Comply with NSF 14 for plastic potable-water-service piping and/or comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.4 DELIVERY, STORAGE, AND HANDLING OF APPURTENANCES

A. Preparation for Transport: Prepare appurtenances, including fire hydrants, according to the following:

1. Ensure that appurtenances are dry and internally protected against rust and corrosion.
2. Protect appurtenances against damage to threaded ends and flange faces.
3. Set appurtenances in best position for handling.

B. During Storage:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature.
3. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle appurtenances if size requires handling by crane or lift.

1. Rig valves to avoid damage to exposed parts.
2. Do not use handwheels or stems as lifting or rigging points.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

B. Notify Engineer not less than two days in advance of proposed utility interruptions. Do not proceed with utility interruptions without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Meter Boxes

1. Ford Meter Box Company
2. Opelika Foundry Company
3. Taylor Foundry Company
4. Equivalent.

B. Backflow Preventers

1. Watts Industries, Inc.; Water Products Div; Model 909S
2. Approved Equivalent.

C. Backflow Preventer Enclosure

1. Lokbox Model No. 2, Northeast Florida Enterprises
2. Approved Equivalent
3. Watts Industries, Inc.; Water Products Div.
4. Approved Equivalent

D. Fire Hydrants

1. Mueller Super-Centurian, Model 200

E. Wall Fire Hydrants

1. Elkhart Brass Mfg. Co., Inc.
2. Fire End & Croker Corporation.
3. Guardian Fire Equipment, Inc.
4. Smith Industries, Inc.; Potter-Roemer Div.
5. Approved Equivalent

F. Post Type Yard Hydrants.

1. Murdock
2. Woodford
3. Kupferle Foundry Co. (The).

4. Approved Equivalent

G. Reel Type Yard Hydrant Hose Valves

1. Jenkins Fig. 112
2. Approved Equivalent

H. Hose Reels

1. Wirt & Knox Catalog No. FD47-1
2. Allenco
3. Ames
4. Approved Equivalent

I. Fire Department Connections

1. AFAC, Inc.; Badger Fire Protection.
2. Elkhart Brass Mfg. Co., Inc.
3. Grinnell Corporation.
4. Approved Equivalent

J. Post Hydrants:

a. Murdock, Inc.
b. Approved Equivalent

K. Vented Reservoir:

a. Hoeptner Products.
b. Simmons Manufacturing Co.
c. Woodford Manufacturing Co.
d. Approved Equivalent

L. Tapping Sleeves and Valves:

1. Mueller, Model H-615
2. Approved equivalent.

M. Pipe Saddles:

1. American Cast Iron Pipe Company
2. Approved equivalent

N. Corp Stops and Fittings

1. Mueller Company
2. Hays Manufacturing Company
3. Ford Meter Box Company, Inc.
4. Approved Equivalent

O. Air Release Valves:

1. Crane Company

2. Powell Company
3. Jenkins Company
4. Approved Equivalent

2.2 WATER SERVICE METERS

A. AWWA C700 Displacement-type Meter :

1. Capacity, accuracy, and test certification shall be in accordance with the above AWWA Specification; and each meter shall be guaranteed for a period of one year from date of installation.
2. Meters shall be notating disc type, magnetic drive, with no connection between disc chamber and gear case.
3. Meters shall be direct reading in gallons, shall have either split-case or C.L. Bottom, frost-proof type; shall have fog-proof tempered register glasses, replaceable and double sealed to register box and gear case; shall have change gears in register face for calibration purposes; and shall have center sweep hands and register covers.
4. Main case, lower case, and register box shall be bronze; disc and ball, hard rubber; thrust roller, stainless steel in corrosion resistant channel; diaphragm, stainless steel; all gaskets, soft rubber, bottoms of corrosion protected cast iron, exterior cap screws and units, brass, all moving parts (spindles, pivots, etc.) and bushings, corrosion resistant alloys.
5. Meter spud sizes shall not be less than 1" I.P.S.; and meter tail piece sizes shall not be less than main connection sizes unless adapters or reducing bushings to effect reduction from main connection size are specified and/or shown in typical service installation detail.
6. All meters shall be equipped with tail pieces and meter couplings.

B. AWWA C701 Turbine type.

1. Capacity, accuracy, and test certification shall be in accordance with the above AWWA Specification; and each meter shall be guaranteed for a period of one year from date of installation.
2. Meters shall be in-line, horizontal axis, high velocity type turbines using magnetic drive, with no connection between disc chamber and gear case.
3. Meters shall be direct reading in gallons, shall have either split-case or C.L. Bottom, frost-proof type; shall have fog-proof tempered register glasses, replaceable and double sealed to register box and gear case; shall have change gears in register face for calibration purposes; and shall have center sweep hands and register covers.
4. Main case, register box, measuring cage, and turbine spindle shall be bronze.
5. Measuring turbine shall be vulcanized hard rubber or suitable engineering plastic with specific gravity approximately equal to that of water.
6. Main case shall have flanged ends or material similar to main case. Flanges shall conform to ANSI B16.1, Class 125

2.3 METER BOXES

A. Boxes shall be constructed of reinforced concrete or cast iron.

B. Concrete boxes shall have tight-fitting concrete covers equipped with insert reading lids of cast iron, hinged type and self-closing; and cast iron boxes shall have cast iron tightfitting lids. All lids shall have the words "WATER METER" or "WATER" integrally cast in the cast iron lid section.

C. Meter boxes for meters 3/4" in size and smaller shall have inside area dimensions approximately 10-5/8" x 17-1/4" or may be not less than 18" more or less in diameter.

2.4 HOSE-CONNECTION, BACKFLOW-PREVENTION DEVICES

A. General: ASSE standard, non-removable type, backflow prevention devices with ASMEB1.20.7, garden-hose threads on outlet.

B. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with manual drain feature. Units attached to rough bronze finish hose connections may be rough bronze. Not suitable for continuous pressure.

C. Hose-Connection Backflow Preventers: ASSE 1052, suitable for at least 3-gpm flow and applications with up to 10-foot head of water back pressure. Include two check valves and intermediate atmospheric vent.

2.5 BACKFLOW PREVENTER

A. General: Backflow Preventer.

1. Bronze body, bronze working parts, stainless steel springs, neoprene valve discs, neoprene coated cotton duck diaphragm
2. Maximum working pressure of 175 psi, hydrostatic test pressure of 350 psi and temperature range of 32^{o}F - 145^{o}F.
3. The device shall consist of two spring-loaded check valves and a spring-loaded, diaphragm actuated, differential pressure relief valve located in the zone between the check valves.
4. All piping in backflow preventer box including backflow preventer shall be insulated with 1" thick fiberglass Micro Lok pipe insulation with weather protective jacket to prevent freezing.
5. Fiberglass enclosure shall be insulated and lockable, with provisions for drainage.
6. Enclosure shall be mounted to 4" thick concrete pad as indicated.

2.6 PROTECTIVE ENCLOSURES

A. Protective Enclosures, General: ASSE 1060, outdoor weather-resistant enclosure designed to protect aboveground water piping equipment or specialties from vandalism. Include size and dimensions indicated but not less than those required for access and service of protected unit.

B. Freeze-Protection Enclosures: Insulated and with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).

1. Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.
2. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.

a. Housing: Reinforced[-aluminum] [or] [-fiberglass] construction.

1) Drain opening for units with drain connection.
2) Access doors with locking devices.
3) Insulation inside housing.
4) Anchoring devices for attaching housing to concrete base.

b. Electric heating cable or heater with self-limiting temperature control.

C. Non-freeze Protection Enclosures: Non-insulated and without heat source.

1. Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.
2. Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.

a. Housing: Reinforced[-aluminum] [or] [-fiberglass] construction.

1) Drain opening for units with drain connection.
2) Access doors with locking devices.
3) Anchoring devices for attaching housing to concrete base.

D. Precast concrete base of dimensions required to extend at least 12 inches beyond edges of enclosure housings. Include openings for piping.

2.7 FIRE HYDRANTS

A. Fire Hydrant: AWWA C502

1. Fire hydrants shall be the 3-way with two (2) 2½" nozzles and pump nozzle. Nozzles shall have National Standard Hose Coupling Threading and shall be equipped with caps and chains.
2. Hydrant shall be "Safety" or "Traffic" Model with safety flanges and safety stem couplings so that hydrant valve will remain tightly closed after upper section has been broken
3. Shall have oil reservoir and oiling system or permanent lubrication system incorporated in bonnet assembly
4. Shall have not less than 5¼" valve opening
5. Shall have 6" inlet opening with mechanical joint connection
6. Shall have National Standard "Pentagon" operating nut

2.8 WALL FIRE HYDRANTS

A. Description: Flush type, two-way wall hydrant with the following:

1. Body: Bronze or cast iron.
2. Inlet: NPS 6.
3. Outlets: Two NPS 2-1/2, with thread according to NFPA 1963 and matching local fire department hose thread. Include lugged caps, gaskets, and chains.
4. Hydrant Escutcheon Plate: Rectangular, with marking "HYDRANT."
5. Hydrant Valve Control: Wall-mounting assembly with extension rod for manual control of valve inside building.

6. Hydrant Valve Escutcheon Plate: Square, with marking "HYDRANT VALVE CONTROL."
7. Finish: Polished bronze.

2.9 HYDRANTS

A. Post-Type Hydrants:

1. Outlet: One, with horizontal discharge.
2. Hose Thread: 2" hose thread outlet
3. Barrel: Galvanized steel.
4. Valve: Bronze body with bronze-ball or plunger closure, self-draining, and anti-freezing with ¼" N.P.T drain port.
5. Operator: T-handle
6. Inlet: 2" I.P. female N.P.T. inlet with union connection.
7. Concrete pad shall be poured at the base of the hydrant as indicated on the drawings.

B. Non-freeze Yard Hydrants:

1. Yard hydrant installations shall consist of the following
2. Hose Thread:3/4" hose thread outlet
3. Barrel: Galvanized steel.
4. Valve: Bronze body with bronze-ball or plunger closure, self-draining, and anti-freezing with 1/8" I.P.S. drain port.
5. Operator: cast iron head and lift handle with lock option.
6. Inlet: 3/4" I.P.S inlet with union connection.
7. Concrete pad shall be poured at the base of the hydrant as indicated on the drawings.
8. Supply lines to yard hydrants shall have the following components

    a. Isolation valve and cast valve box and lid installed adjacent to hydrant.
    b. Concrete apron pad stamped with embedded aluminum plate with the words "EFFLUENT WATER".

2.10 CROSS ANCHOR ASSEMBLIES

A. Cross anchor assemblies, furnished and installed complete, shall be provided at locations as indicated and/or as directed by the Engineer.

B. Cross anchor assemblies shall consist of:

1. One (1) length (18 ft. minimum) of Ductile Iron Pipe, ANSI A21.51, Class 53, Mechanical Joint, w/ 1½" in width x 4½" in height steel anchor fin welded 6 ft. back of bell
2. One concrete cross anchor with dimensions and reinforcing steel as indicated
3. Class A concrete as described in these Specifications.
4. One mechanical joint plug.

2.11 TAPPING SLEEVES AND VALVES

A. Tapping Sleeves

1. Tapping sleeves shall be bolted split type having gaskets extending the entire length of the sleeves to form a watertight joint when bolted in place.
2. Tapping sleeves shall be ductile iron, and metal shall conform to the respective chemical and physical properties specified for ductile iron fittings in ANSI A21.10/AWWA C110.
3. Walls of sleeves shall be extra heavy, and the sleeves shall accommodate ductile iron pipe of the various standard thickness classes.
4. Sleeves shall be equipped with either mechanical joint ends or caulk type ends, according to the suitability of the sleeve to accommodate the pipe to be tapped.

    a. Sleeves equipped with mechanical joint ends shall be used to the maximum extent possible, that is, wherever found to be suitable.
    b. The Contractor shall determine the suitability of the particular type of end for accommodating the pipe before ordering the sleeve.
    c. The Contractor shall carefully measure the O.D. of the pipe to be tapped to make certain that he will have sleeves equipped with correct ends of correct patterns.

B. Tapping Sleeves and Saddles for PVC Pressure Class Pipe

1. Tapping sleeves for pressure class PVC lines shall be of heavy welded steel with recessed grove to retain gaskets.
2. Gasket shall be Buna-N ASTM D2000 with broad cross - section to resist rolling and provide dependable seal.
3. Finish coat shall consist of 12 mils of fused epoxy coating.
4. Bells and nuts shall be 18-8 stainless steel.
5. Shall be Ford "Style FTSC", or equivalent.
6. Tapping saddles are also acceptable for PVC pressure class pipe

C. Branch Outlets

1. Branch outlets of sleeves shall be equipped with flanges made with female faces to accommodate raised male faces of tapping valves.
2. Before the pipe is tapped the Contractor shall close the branch with a tapped blind flange and shall test the sleeve at pressure of 100 psi above the line pressure (of the pipe to be tapped) specified and/or as indicated.

D. Tapping Valves

1. Tapping valves shall meet or exceed the requirements of these Specifications for AWWA gate valves and pressure rated ductile iron valves in all respects except for ends and seat rings.
2. The tapping side of the valve shall be equipped with flange having raised male face to ensure proper alignment with the sleeve, and the outlet of the valve shall be equipped with flange having slotted bolt holes for attachment of tapping machine.
3. The flange shall either be suitable for mechanical joint connection or shall have caulking recess for making a caulked-type joint as required.
4. Seat rings shall be oversized so as to permit the use of cutters of the full nominal size of the tapping valves.

2.12 PIPE SADDLES

A. Pipe saddles shall be manufactured from ductile iron and shall have positively confined "O-Ring" type sealing gaskets.

B. Pipe saddles shall be equipped with high strength stainless steel (or Cor-Ten Steel) straps with minimum cross section dimensions of ¼"x1½" and fabricated with hexagonal nuts for fastening to transmission mains.

C. Pipe saddles shall be furnished with mechanical joint outlets conforming to the requirements of ANSI A21.11 (AWWA C111); or, with flange outlet conforming to the requirements of ANSI A21.15 (AWWA C110), as indicated and/or as described in these Specifications.

D. Inside diameter of saddle outlet shall be ¼" greater than the nominal in order that a full size opening can be made in pipe wall.

2.13 BLOW-OFF ASSEMBLIES

A. Blow-Off assemblies, furnished and installed complete, shall be provided in locations indicated.

B. Blow-Off assemblies shall consist of the following:

1. One (1) main line butterfly valve (of diameter indicated) MJ & MJ, with operator extension, valve box, and cover
2. Two (2) eight inch gate valves, MJ & MJ, with operator extensions, valve boxes and covers
3. One (1) reinforced concrete headwall assembly in accordance with the details provided
4. One (1) eight inch flap valve, Flg'd
5. All general concrete bracing
6. All miscellaneous Ductile Iron Pipe, ANSI A21.51, of Class indicated, and associated fittings, appurtenances, and retainer glands and all miscellaneous work required to construct a particular blow-off assembly in accordance with the details provided

C. All pipe, fittings, valves, appurtenances, concrete, reinforcing steel, excavation (including rock excavation and disposal), earthwork, bedding and backfill, concrete pipe braces, final grading, and all other materials and/or work required to construct the blow-off assemblies shall comply with the applicable requirements of these Specifications and with the details provided.

2.14 SPECIAL THRUST COLLAR AND RESTRAINED BEND ASSEMBLIES

A. Special thrust collar and restrained bend assemblies, furnished and installed complete, shall be provided at the locations indicated on the Drawings.

B. Special thrust collar and restrained bend assemblies shall consist of the following (Diameters and thicknesses of pipes and steel thrust collars shall be as indicated):

1. One (1) length (18 ft. minimum) of Ductile Iron Pipe, ANSI A21.51, Class 51, one end plain for insertion into P-O joint bell and one end adapted for insertion into bell of restrained joint fitting
2. One (1) length (18 ft. minimum) of Ductile Iron Pipe, ANSI A21.51, Class 51, one end adapted for insertion into restrained joint fitting and one end P-O joint bell for acceptance of spigot end of P-O pipe
3. One (1) steel thrust collar welded to the Ductile Iron Pipes at the point indicated
4. One (1) 90^{o} restrained joint bend
5. Two (2) special concrete anchors with dimensions and reinforcing steel as indicated.

C. Restrained joint bends shall be:

1. In accordance with the requirements of ANSI A21.10, latest revision, and AWWA C150 and C151
2. Rated for working pressures of not less than 250 psi,
3. Similar and equivalent to American Cast Iron Pipe Company "LOK-FAST" fittings.
4. Tar coated outside and cement lined inside in accordance with the requirements of ANSI A21.4 or AWWA C104, latest revision.
5. Suitable for such use as indicated and as described herein.

D. Locking of the restrained joint bend to the pipe shall be accomplished by means of the following:

1. Special mechanical joint bell
2. Follower gland
3. Alloy steel bolts and nuts
4. ½" square (min.) alloy steel retaining ring welded to the spigot end of the pipe

E. Concrete utilized in construction of cross anchor shall have a 28-day compressive strength of not less than 3500 psi, and shall comply with the applicable requirements of these Specifications.

2.15 AUTOMATIC AIR RELEASE VALVE ASSEMBLIES FOR WATER SERVICE

A. Automatic air release valve assemblies, furnished and installed complete for venting accumulation of air in the finished water mains, shall be provided in locations as indicated.

1. Automatic air release valve assemblies shall be provided for the particular main sizes in accordance with the details shown and as described hereinbelow.

B. Automatic air release valves for installation on 24" diameter and smaller Ductile Iron Mains shall be similar and equivalent to APCO #145C, 2" inlet pipe thread, suitable for operating pressures below 150 psi.

1. Air release valves shall be combination type, single body, double orifice with large orifice having a diameter of 2" and small orifice having a diameter of 3/32".
2. Valve body and cover shall be cast iron in accordance with ASTM A48, Class 30.
3. Float shall be stainless steel in accordance with ASTM A240.

C. Each air release valve assembly shall consist of the following:

1. One (1) Mueller double strap service saddle
2. One (1) corporation stop, Mueller H-10045, Mueller Thread x 2" I.P. thread (inside)
3. Five (5) brass or copper pipe nipples (2")
4. One (1) brass or copper union (2")
5. One (1) brass or copper tee (2"x2"x2")
6. Two (2) gate valves, wedge disc, rising stem, 2" Crane #431-UB, w/handwheel
7. One (1) air release valve as specified hereinabove
8. One (1) air release valve vault as specified herein.

D. The air release valve shall not be placed in service until the water main has been flushed out and all the air has been manually vented through the horizontal bypass valve during water main filling operation.

E. Fitting numbers are given for identification of type. Stops and fittings may be as manufactured by the following:

1. Mueller Company
2. Hays Manufacturing Company
3. Ford Meter Box Company, Inc
4. Approved equivalent

F. Crane valve numbers are given for identification of type. Valves of similar type as manufactured by the following:

1. Powell,
2. Jenkins,
3. Approved equivalent

G. Valves shall be in accordance with the requirements of these Specifications.

2.16 MANUAL AIR RELEASE VALVE ASSEMBLIES

A. Manual air release valve assemblies, furnished and installed complete, shall be provided in locations as indicated and/or as requested by the Engineer.

B. Air release valve assemblies shall consist of the following:

1. One 3/4" corporation stop, Mueller H-15000
2. One 3/4" corporation stop, Mueller H-150008
3. 3/4" copper water tube, type K (hard) of length as required
4. One (1) straight coupling 3/4" copper to 3/4" outside pipe thread Mueller #H-15425
5. One (1) straight coupling 3/4" copper to 3/4" outside pipe thread Mueller #H-15428
6. One (1) 3/4" bronze angle valve, 150# service, Crane #16½P, w/handwheel
7. One (1) concrete meter box.

C. Valves shall be in accordance with the requirements of these Specifications.

D. Meter box shall meet the requirements of these Specifications.

E. Approximately 2 cubic feet of crushed stone shall be provided beneath the meter box.

2.17 AIR RELEASE VALVE VAULTS

A. Valve vaults for housing automatic air release valve assemblies shall be constructed of either:

1. poured in place reinforced concrete or
2. precast concrete manhole sections as identified on the Drawings and as described herein.

B. Precast concrete manhole sections shall be 5 ft. O.D. manhole risers without bottom slab and sections shall have flat slab top (eccentric opening) with cast in place frame and cover.

C. Frames and Covers

1. Frame for cover shall be integrally cast within the manhole flat slab top during manufacture of manhole top.
2. Field setting of manhole frame in precast slab will not be allowed.
3. Frames and covers shall be of pattern provided.

D. Vaults shall be constructed in accordance with details provided.

1. Access openings in top of slab shall be equipped with cast iron frames cast in top slab with cast iron covers.
2. Vaults shall be equipped with cast iron ladder steps.
3. Vaults shall be set at the proper elevations to allow acceptable top, bottom and side clearances for air release and valve assembly.

E. The Contractor is responsible for determining required depth and elevations of vaults to assure correct orientation of vaults.

F. Top of vault shall be set flush with ground surface.

2.18 VALVE MARKERS

A. The Contractor shall furnish and install valve markers for all valves installed in locations other than in city streets or for locations identified on the Drawings and/or as directed by the Engineer.

B. Valve markers shall be precast, reinforced concrete posts, 4"x4" or 4"x5" in cross-section, and 6'-0" long.

C. Markers shall be equipped with brass discs (as for monuments and benchmarks) set monolithically in top of post.

D. Posts shall be marked "ARV" for air release valve.

E. After post has been set, there shall be die-stamped on face of disc an arrow indicating the location of the valve with respect to the marker, and there shall also be stamped on the disc the measured distance of the valve from the marker.

F. Valve markers shall be set within 2'-0" of the right-of-way boundary in the general vicinity of the valves to be referenced.

G. Placement of valve markers shall be at the direction of the Owner.

2.19 POTABLE WATER SYSTEMS AND APPURTENANCES WITHIN WWTP'S

A. The wastewater plant shall be served by city water (potable water); and high pressure plant effluent (non-potable water).

1. City water shall be used for supplying the following:

a. All lavatories
b. Showers
c. Drinking fountains
d. Water closets
e. Water heaters
f. Water coolers
g. Sinks in buildings
h. Lavatory fixtures and refrigerators (icemakers)

2. Effluent water shall be used for supplying the following:

a. Exterior hose bibbs
b. Constant purging systems (pump seals)
c. Basin washdown

B. High pressure plant effluent shall be delivered to the high pressure effluent water system by a hydro pneumatic system located where indicated.

1. High pressure effluent water shall be used for the following:

a. flushing pipe lines;
b. for washdown of clarifiers, basins and for lawn watering,
c. and for flushing equipment after use.

2. The effluent water system shall be complete with the following:

a. Pumps
b. Piping
c. Valves
d. Fittings
e. Hangers
f. Supports and all appurtenances

C. Pipe shall be ductile iron, schedule 80 PVC, stainless steel, alloy steel (galvanized) or copper as specified herein and as indicated.

D. Valves shall be as specified herein and as indicated.

E. Flushing Connections shall be furnished and installed where indicated on the Drawings. Each connection shall be comprised of the following:

1. 1 inch I.P.T. tap in tapping boss on cast iron pipe or fitting;
2. 1 inch x 1 inch hex nipple, brass,
3. 1 inch I.P.T. each end, hex nut center;
4. 1 inch gate valve, adapter, male 1 inch I.P.T. one end, and male 1 inch hose thread other end, brass construction, for 1 inch x 1 inch swivel nut female union connector, brass, hose thread.

F. Wash-up Hose shall be suitable for 150 psi working pressure; shall be reinforced with rayon cord, 2-braid; shall be 1 inch size, shall have smooth black rubber tube and black rubber cover; and shall be product of Goodrich; Goodyear; or equivalent. Hose shall be furnished with each hose reel in sections 100 feet in length; and each section shall be complete with 1 inch brass hose couplings, male one end and female swivel (union) other end.

G. Hose Nozzles shall be cast brass, satin finish, 8 inches long; shall have 1 inch hose thread female inlet and 5/16 inches tip discharge; and shall be Allenco; Elkhart; or equivalent. One (1) hose nozzle shall be provided for each 100 foot section of hose mounted on hose reels.

H. Portable Hose Wagons shall each be equipped with 100 LF of 1 inch wash-up hose as specified and with one (1) hose nozzle as specified hereinabove. Portable hose wagons shall be Ames Hose Wagon; Wirt & Know; Elkhart; or equivalent.

I. Hose Bibbs shall be of brass construction, metal handwheel, male hose thread outlet, frost-proof (exterior), NIBCO, or equivalent.

J. Hose Gate Valves shall be as specified in these Specifications.

K. Yard Hydrants shall be as specified in these Specifications.

L. All threads on yard hydrants, hose gate valves, wash-up hose couplings, adapters for wash-up hose and flushing connections and wash-up nozzles shall be either American (National) Standard Fire Protection Hose Thread or Iron Pipe Hose Thread, provided that all threads on all such equipment, appurtenances, and connections are the same.

1. It shall be the Contractor's responsibility to make certain that all threads on such items are the same.

M. Fire Hose shall be mill hose 2-1/2 inch, 200# test, single jacket, cotton/polyester construction with synthetic rubber lining, impregnated with non-toxic fungicide solution for mildew resistance, National Fire Hose Corporation; or equivalent. Each 100 foot section of hose shall be equipped with cast brass (brushed finish) pin lug couplings.

N. Hose Carts shall have capacity for and be furnished with 300 feet of fire hose as specified hereinabove; shall be medium capacity; and shall be Wirt & Knox No. J-0½, or equivalent.

O. Spanner Wrenches shall be galvanized malleable iron, Factory Mutual Approved, to fit hose coupling specified hereinabove. Two shall be furnished.

P. Fire Hose Nozzles shall be cast brass, satin finish, 15 inches long, 2-1/2 inch bottom thread, 1 inch tip discharge, Allenco or Elkhart, with handle grip.

Q. Warning Tags shall consist of "NON-DRINKING WATER" plastic tags with engraved black letters on a yellow background on non-potable water outlets as required.

1. The tags shall be triangular, shall have equal 4" long sides, and shall have a stainless steel chain for fastening.
2. The tags shall be installed on every plant effluent water outlet (non-potable) on the site of the wastewater treatment plant.
3. Ten tags and chains shall be furnished to the Owner as spares.
4. The tags shall be similar and equivalent to Type EVT-1, Seton Name Plate Corp., New Haven, CT.

2.20 SERVICE INSTALLATIONS

A. The Contractor shall furnish all labor, materials, and equipment, and shall make the service installations complete in accordance with the Plans and Specifications.

B. Each service installation shall consist of the following:

1. Tapping of water main
2. One (1) service clamp or saddle, Mueller double-strap or Dresser wide band
3. One (1) corporation stop, with straight coupling or one-eighth bend coupling as required, and of size indicated or specified
4. Length of copper water tube, Type K Hard, sufficient to run from main to meter location, and of size indicated or specified
5. One (1) adapter coupling, copper water tube to inside I.P. thread
6. One (1) reducing coupling or bushing when required
7. One (1) curb stop, inverted key round way, inside I.P. thread inlet and outlet
8. One (1) meter set with tailpieces having outside I.P. threads
9. One (1) meter as specified hereinabove
10. One (1) meter box as specified hereinabove

C. Components of each service installation shall be those adopted as standard for the system and approved by the Owner.

2.21 SERVICE TRANSFERS

A. Service transfers from existing mains to new mains, when existing meters and meter boxes are to be utilized (remain in service and in existing location), shall be accomplished as specified hereinbelow.

B. Service transfers from existing mains to new mains shall consist of the following:

1. Tapping of new water main
2. One (1) service clamp or saddle, Mueller double-strap or Dresser wide band
3. One (1) corporation stop, with straight coupling or one-eighth bend coupling as required, and of size indicated or specified
4. Length of copper water tube, Type K Hard, sufficient to run from new main to existing meter location, and of size indicated or specified
5. All necessary connections

C. Components of each service transfer shall be those adopted as standard for the system and approved by the Owner.

2.22 SERVICE RELOCATIONS

A. Service relocations where service will be transferred from existing mains to new mains and the meter location will be moved, shall be accomplished as specified below.

1. Tapping of new water main
2. One (1) service clamp or saddle, Mueller double-strap or Dresser wide band
3. One (1) corporation stop, with straight coupling or one-eighth bend coupling as required, and of size indicated or specified
4. Length of copper water tube, Type K Hard, sufficient to run from new main to new meter location, and of size indicated or specified
5. Move and reinstall in new location the existing meter, meter box, and all associated appurtenances
6. Length of copper water tube, Type K Hard, sufficient to run from new meter location to connection with existing service line, and of size indicated or specified
7. All necessary connections

B. Service relocations from existing mains to new mains where new meters and appurtenances will be installed shall consist of the following:

1. Tapping of new water main
2. One (1) service clamp or saddle, Mueller double-strap or Dresser wide band
3. One (1) corporation stop, with straight coupling or one-eighth bend coupling as required, and of size indicated or specified
4. Length of copper water tube, Type K Hard, sufficient to run from new main to new meter location, and of size indicated or specified
5. Move and reinstall in new location the existing meter, meter box, and all associated appurtenances
6. One (1) adapter coupling, copper water tube to inside I.P. thread
7. One (1) reducing coupling or bushing, when required
8. One (1) curb stop, inverted key round way, inside I.P. thread inlet and outlet
9. One (1) meter set with tailpieces having outside I.P. threads
10. One (1) meter as specified herein
11. One (1) meter box as specified herein
12. Length of copper water tube, Type K Hard, sufficient to run from new meter location to connection with existing service line, and of size indicated or specified
13. All necessary connections

C. Components of each service relocation shall be those adopted as standard for the system and approved by the Owner.

2.23 CASED SERVICE PIPE

A. Where service pipe is shown to be installed across paved streets or paved roads the service pipe shall be run in protective casing pipe.

B. Casing pipe shall be installed by jacking or by boring and jacking, the method being dependent upon the materials encountered and the Contractor's option.

1. Whichever method may be used, the casing pipe shall be installed straight and true so as to permit free and easy installation of service pipe within casing pipe without the need for driving the service pipe.

2. Casing pipe shall be black steel pipe, ASTM A53, Schedule 80, and shall be of size specified and/or indicated, however in no case shall casing pipe be less than 2 inches in diameter.

PART 3 - EXECUTION

3.1 PIPELAYING

A. Minimum depth of cover for all pipe shall be 3'-0" unless otherwise shown. The Contractor shall excavate the trenches to such depths so as to obtain the cover specified hereinabove or as indicated.

B. Minimum depth of cover for ALDOT utility relocation work is forty (40) inches, unless otherwise shown.

C. Pipe Installation

1. Installation and joining of pipe shall be performed in accordance with the requirements of ANSI/AWWA C600 (for ductile iron pipe) or C605 (for PVC pipe), latest revision, and with the requirements of these Specifications.
2. Pipe shall be installed so as to conform to the alignment and grade indicated. If other utilities, pipe, cables, conduits, etc., are encountered they shall be handled as described in these Specifications.

3. Pipe shall be laid so that the invert elevations will correspond to those indicated for the particular stations along the pipe line.

    a. The difference in elevation between any two consecutive grade points (elevation control points or stations) shall be uniformly and proportionately distributed between the pipe lengths comprising the section of pipe line between such control points.
    b. The maximum deflection for a particular size and length of pipe shall be in accordance with the manufacturer's recommendations.

4. Proper and suitable tools and appliances for handling of the pipe shall be used.
5. The bottom of the trench shall be prepared as described in these Specifications.
6. Each piece of pipe or fitting shall be cleaned and carefully examined for defect.
7. No defective pipe or fittings shall be used. If a defective piece should be discovered after having been used it shall be removed and replaced with a non-detective piece by the Contractor at the Contractor's expense.
8. The pipe shall be accurately installed to the lines and grades indicated
9. Whenever a length of pipe requires cutting to fit the lines, it shall be done as to leave a smooth end at right angles to the axis of the line; and the Contractor shall not receive extra compensation for this work.
10. Open ends of the unfinished pipe line shall be securely closed when the work is stopped temporarily at night or other times.

3.2 BRACING OF PIPE AND FITTINGS

A. All piping shall be braced against internal thrust by means of restrained joints and/or poured-in-placed concrete bracing where changes in direction occur or where branches from the line are located.

B. Braced underground piping shall be securely braced against movement with concrete thrust blocks and bearing against solid, undisturbed ground. Where solid or undisturbed ground cannot be obtained for bracing or where indicated on the Drawings restrained joint pipe and/or fitting shall be required.

C. Concrete braces shall be constructed in accordance with details shown on the Drawings; and shall be plain or reinforced as indicated or required. All reinforced concrete used in underground bracing shall be "Class A" concrete in accordance with the requirements of these Specifications.

D. Special bracing for particular locations identified on the Drawings and/or described herein shall be in accordance with details shown on the Drawings for the particular special brace and shall be complete with reinforcing steel and miscellaneous metal work.

E. Piping installed above ground in buildings, galleries, tunnels, piping trenches and chases shall be supported and braced as indicated on the Drawings and specified herein.

1. Where pipes are braced or supported above ground piping by means of concrete piers or thrust blocks, the concrete used for construction of such piers or thrust blocks shall be:

a. Class "A" as specified in these Specifications
b. Reinforced
c. Anchored to slabs and/or walls by dowels
d. Finished to match adjacent concrete surfaces or finished surfaces of adjacent walls or floors, whichever is applicable.

3.3 METER BOX INSTALLATION

A. Meter boxes shall be furnished and installed for all meter installations.

B. Meter boxes shall be of such depth as to provide a meter setting depth of not less than 18", and depth extension shall be provided when greater setting depth is required at particular locations.

3.4 BACKFLOW-PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers with relief drain in vault or other space subject to flooding.

C. Do not install bypass piping around backflow preventers.
D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.5 FIRE HYDRANT INSTALLATION

A. Hydrants shall be so set that 'bury' line is at surface of ground and such that the adjoining finish grade within a three (3) foot radius is within 2 inches of the bury line.

B. The lower barrel section of each hydrant shall be of such length (from safety flange to shoe) as to adjust the 'bury' line to suit trench depth at the particular location.

C. The location of each hydrant shall be field checked for the purpose of determining the length of lower barrel section required for the particular location.

D. Hydrants shall be set plumb and true with proper nozzles facing street or curb.

E. Broken stone (gradation 1½" to 2½") shall be placed around hydrant drainage opening to permit effective drainage of barrel. Volume of stone shall not be less than two (2) cubic feet.

F. Fire hydrant leads

1. Less than or equal to 60 inches in length shall be ductile iron with integrally cast mechanical joint gland on one end and an integrally restrained rotatable mechanical joint gland on the other end.
2. Greater than 60 inches in length shall be Ductile Iron Pipe with ductile iron gripper glands for ends of lead.

G. The anchoring pipe section shall be complete with glands and bolts for connection to mechanical joint fittings and mechanical joint shoes.

H. Mechanical joint tee shall be a valve and hydrant type tee having standard MJ connections on the run of the tee and a ductile iron integrally restrained rotatable MJ gland on the plain end branch for direct connection to MJ & MJ valve.

3.6 HYDRANT INSTALLATION

A. Install yard-type hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve, valve box, concrete pad with aluminum tag and restrained joints in supply piping.

3.7 CONNECTIONS

A. The Contractor shall make all connections to existing mains as indicated and as specified herein.

1. These connections shall be made at such times and in such manner as will keep to a minimum any interruptions of service or inconvenience to users of the system.
2. Connections to the existing system shall only be made after obtaining permission from the Owner specifically for each connection.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.8 PIPELINE TESTING

A. The Contractor shall furnish all equipment, labor, materials, and supervision necessary to perform the tests required.

1. The Contractor shall bear the cost of testing, retesting, and any replacement work required (including all materials required).
2. The Contractor is reminded that he is solely responsible for observance of all safety regulations and for the maintenance of safe conditions during all testing work.
3. Should any pipe line, or any section of the line fail to meet the criteria established hereinbelow, all deficiencies shall be corrected and the testing repeated until the specified test results have been achieved.

B. All pipelines shall be tested in accordance with procedures and practices applicable to the various types and kinds of pipe and to the various sizes of pipe.

1. The Contractor is reminded that personnel not experienced in testing procedures and practices, and particularly in air-testing of pipelines, should neither be allowed to conduct the test nor assist in the test procedures.

C. Testing Water Supply Mains

1. The Contractor shall furnish all meters, gauges, pressure recorders, test plugs, valves, couplings, pitot gauges, test piping and fittings, pumps, compressors, receivers, motors, engines, electric power, fuel, water, supplies, labor tools, materials, equipment and supervision necessary to perform the tests required and shall make all connections necessary to perform the tests required.
2. Should any pipe line, or any section of the line, fail to meet the criteria established hereinbelow, any deficiencies shall be corrected and the testing repeated until the specified test results have been achieved.
3. All water supply mains and other water lines underground shall be tested in accordance with the requirements of ANSI/AWWA C600 (for ductile iron pipe) or C605 (for PVC pipe) and in accordance with the requirements of these Specifications.
4. Test pressure shall not be applied to instruments, controls, regulators or equipment.
5. Sections of mains placed under test shall be 1200 feet or less in length unless the concurrence of the Engineer is first secured.

    a. Test sections may not exceed 3000 feet in length.
    b. Sections of mains to be placed under test shall be isolated by means of valves or test plugs.

6. The duration of the test shall be 24 hours, and the test pressure shall be 150 psi or 1½ times the normal working pressure, whichever is greater.
7. Pressure shall be recorded on a 24 hour pressure recorder satisfactory to the Engineer and test charts shall be provided to the Engineer prior to acceptance of testing.
8. No pipe line, or section of pipe line, will be accepted if the leakage is greater than that as determined by application of the following formula:

$$L = SD \times (\sqrt{P}/133{,}200)$$

where,

L = Allowable leakage in gallons per hour
D = Nominal diameter of pipe in inches
S = Length of pipe being tested in feet
P = Average test pressure in PSIG

9. During testing the pressure in the main or line being tested shall be maintained as closely as possible to the test pressure specified.

    a. The pressure shall not be allowed to fall more than 5 psi below the specified test pressure.
    b. Should the pressure be allowed to drop more than 5 psi the test shall be re-started.

10. The water added to the main or pipe line in order to maintain the desired test pressure shall be metered through a bench-tested meter registering in gallons and fractions of a gallon.
11. The quantity of water added to the main or line during the test period shall be the leakage.
12. All visible leaks shall be repaired even when tested leakage rates are less than the limits as determined by application of the formula given hereinabove.
13. Prepare reports of testing activities.

3.9 DISINFECTION AND CLEANING

A. Water Mains and Hydrants

1. The Contractor shall disinfect the pipe, pipe fittings, valves, and hydrants installed in the system.
2. In general, all disinfection shall be in accordance with AWWA C651, latest revision.
3. The interior of the pipe fittings and accessories shall be kept clean and free from dirt; pipe shall be cleaned before installation; and shall be protected during laying to prevent earth entering pipe.
4. During periods when pipe laying is not in progress, open ends of laid pipe shall be protected by means of water-tight plug or other means satisfactory to the Engineer.
5. All joints of pipe in trench shall be made up tightly before stopping work at night.
6. After the mains are laid and pressure tested, they shall be dechlorinated prior to flushing thoroughly, either through fire hydrants or by means of taps at the end of the mains (the taps to be large enough to insure a velocity of at least 2.5 f.p.s. in the mains). Should the flushed water not be dechlorinated, it shall be put into a temporary holding basin for natural dechlorination.
7. The mains shall be chlorinated (after flushing) with sufficient liquid chlorine, or powdered chlorine, to provide at least 50 mg/L available chlorine to the water in the mains.

    a. The chlorine solution shall remain in the pipe at least 24 hours and then flushed until main is filled with water having normal chlorine residual.
    b. Samples for bacteriological examination by the State Health Department shall be taken on consecutive days (two sets of samples taken 24 hours

apart) by the Contractor and delivered to the State Health Department; and if the water quality does not meet the standards of the Health Department, the disinfection process shall be repeated until satisfactory water is obtained.

c. Samples for bacteriological examination shall be collected at not greater than 2,000 foot intervals along transmission mains.

8. The Contractor shall furnish all chemical feed pumps, generator sets, valves, connections, materials, labor and equipment required for proper disinfection of the mains.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 22 11 13

SECTION 22 13 13 - SANITARY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes sanitary sewerage piping and specialties outside buildings for the following:

1. Automatic Air Release Valve Assemblies for Wastewater Service
2. Manual Air Release Valve Assemblies
3. Air Release Valve Vaults
4. Valve Markers
5. Pipelaying
6. Bracing of Pipe and Fittings
7. Pipeline Testing
8. Connections to Existing System

1.2 SUBMITTALS

A. Product Data: For the following:

1. Automatic Air Release Valve Assemblies for Wastewater Service
2. Manual Air Release Valve Assemblies
3. Air Release Valve Vaults
4. Valve Markers

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.4 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Automatic Air Release Valves

1. APCO Series 445 VVA
2. Golden Anderson

2.2 AUTOMATIC AIR RELEASE VALVES FOR WASTEWATER SERVICE

A. Automatic air release valves shall be sewage air and vacuum valves of sizes as indicated.

B. Automatic air release valve assemblies shall be furnished and installed complete as shown on the Drawings.

C. Sewage Air and Vacuum Valves

1. Sewage air and vacuum valves shall utilize two stainless steel floats to vent large volumes of air from the force main when filling, and to allow air to reenter the force main to prevent vacuum conditions when draining.

a. Valve shall incorporate an air gap between the two floats to prevent solids from clogging the top shut off float.
b. Valve shall withstand 500 psi test pressure.

2. The following additional components shall be included:

a. Inlet valve
b. Blow-off valve
c. Quick disconnect couplings
d. Five feet of flushing hose

3. Materials of construction shall be as follows:

a. Body, Cover and Baffle shall be Cast iron, ASTM A 126 Gr. B
b. Upper and Lower Floats and Float Stem shall be Stainless Steel, ASTM A240
c. Seat shall be Buna N

D. Combination Sewage Air Valves

1. Combination Sewage Air Valves shall consist of a sewage air and vacuum valve and a sewage air release valve.
2. Valve shall be dual function, venting large volumes of air through the air and vacuum valve and venting small pockets of air under pressure through the air release valve.
3. The air and vacuum valve shall also allow large amounts of air to re-enter to break any developing vacuum.
4. The air release valve shall have the following:

    a. Two-inch NPT inlet and
    b. Two-inch all bronze isolation gate valve

5. The air and vacuum valve shall have the following:

    a. Flanged inlet
    b. Isolation butterfly valve

6. Valves shall be supplied with the following:

    a. Blow-off and flushing valves
    b. Quick disconnect couplings
    c. Five feet of flushing hose.

7. Materials of construction shall be as specified for sewage air and vacuum valves hereinabove.

2.3 MANUAL AIR RELEASE VALVE ASSEMBLIES

A. Manual air release valve assemblies, furnished and installed complete, shall be provided in locations as indicated and/or as requested by the Engineer.

B. Air release valve assemblies shall consist of the following:

1. One 3/4" corporation stop, Mueller H-15000 (flared), or Mueller H-150008 (compression)
2. ¾" copper water tube, type K (hard) of length as required
3. One (1) straight coupling 3/4" copper to 3/4" outside pipe thread Mueller H-15425 (flared), or Mueller H15428 (compression).
4. One (1) 3/4" bronze angle valve, 150# service, Crane #16½P, w/handwheel
5. One (1) concrete meter box or valve box.

C. Valves shall be in accordance with the requirements of these Specifications.

D. Meter box shall meet the requirements of these Specifications.

E. Approximately 2 cubic feet of #57 (clean) stone shall be provided beneath the meter box.

2.4 AIR RELEASE VALVE VAULTS

A. Valve vaults for housing automatic air release valve assemblies shall consist of one of the following:

1. Cast-in-place or Pre-cast concrete vault: Vaults shall be reinforced and shall be constructed in accordance with details provided on the Drawings, but in no case shall the walls and slabs be less than 6-inches thick. Access openings in top of slab shall be equipped with aluminum or cast iron frames cast in top slab with aluminum or cast iron covers. Vaults shall be equipped with cast iron ladder steps. Vaults shall be set at the proper elevations to allow acceptable top, bottom and side clearances for air release and valve assembly.
2. Precast concrete manhole sections: Precast concrete manhole sections shall consist of a minimum of 5 ft. I.D. manhole risers without a bottom slab and the top shall consist of a flat slab with a cast in place frame and cover. Frame for cover shall be integrally cast within the manhole flat slab top during manufacture of manhole top. Field setting of manhole frame in precast slab will not be allowed. Frames and covers shall be of pattern specified.

B. The Contractor is responsible for determining required depth and elevations of vaults to assure correct orientation of vaults.

C. Top of vaults shall be set flush with ground surface.

2.5 VALVE MARKERS

A. The Contractor shall furnish and install valve markers for all valves installed in locations other than in city streets or for locations identified on the Drawings and/or as directed by the Engineer.

B. Valve markers shall be precast, reinforced concrete posts, 4"x4" or 4"x5" in cross-section, and 6'-0" long.

C. Markers shall be equipped with brass discs (as for monuments and benchmarks) set monolithically in top of post.

D. Posts shall be marked "ARV" for air release valve.

E. After post has been set, there shall be die-stamped on face of disc an arrow indicating the location of the valve with respect to the marker, and there shall also be stamped on the disc the measured distance of the valve from the marker.

F. Valve markers shall be set within 2'-0" of the road or street right-of-way boundary in the general vicinity of the valves to be referenced.

G. Placement of valve markers shall be at the direction of the Owner.

PART 3 - EXECUTION

3.1 PIPELAYING

A. Minimum depth of cover for all pipes shall be 3'-0" unless otherwise shown. The Contractor shall excavate the trenches to such depths so as to obtain the cover specified hereinabove or as indicated.

B. Ductile Iron Pipe

1. Installation and joining of ductile iron pipe shall be performed in accordance with the requirements of ANSI/AWWA C600, latest revision, and with the requirements of these Specifications.
2. Ductile iron pipe shall be installed so as to conform to the alignment and grade indicated. If other utilities, pipe, cables, conduits, etc., are encountered they shall be handled as described in these Specifications.
3. Ductile iron pipe shall be laid so that the invert elevations will correspond to those indicated for the particular stations along the pipe line.

    a. The difference in elevation between any two consecutive grade points (elevation control points or stations) shall be uniformly and proportionately distributed between the pipe lengths comprising the section of pipe line between such control points.
    b. The maximum deflection for a particular size and length of pipe shall be in accordance with the manufacturer's recommendations.

4. Proper and suitable tools and appliances for handling of the pipe shall be used.
5. The bottom of the trench shall be prepared as described in these Specifications.
6. Each piece of pipe or fitting shall be cleaned and carefully examined for defect.
7. No defective pipe or fittings shall be used. If a defective piece should be discovered after having been used it shall be removed and replaced with a non-detective piece by the Contractor at the Contractor's expense.
8. The pipe shall be accurately installed to the lines and grades indicated
9. Whenever a length of pipe requires cutting to fit the lines, it shall be done as to leave a smooth end at right angles to the axis of the line; and the Contractor shall not receive extra compensation for this work.
10. Open ends of the unfinished pipe line shall be securely closed when the work is stopped temporarily at night or other times.

C. PVC Pipe Sewers

1. Pipe shall be installed in trenches in accordance with the requirements of ASTM D 2321-83a and in accordance with the requirements of these Specifications.
2. The pipe shall be accurately laid to the lines and grades indicated.
3. All dirt, excavated materials or other foreign materials shall be prevented from entering the pipe.
4. Each piece of pipe, before being lowered into the trenches, shall have been cleaned, shall have been examined for defects, and shall have been judged to be suitable for installation in the pipeline.
5. The first length of pipe installed at any starting point in the pipeline shall be firmly anchored to prevent movement by completion of bedding and backfilling operation before the next length of pipe is installed.

D. Cast Iron Soil Pipe

1. Installation of cast iron soil pipe shall be performed in accordance with the requirements of these Specifications, and joining of cast iron soil pipe shall be performed in accordance with the recommendations of the manufacturer of the joining system specified to be used with the cast iron soil pipe.

E. Vitrified Clay Gravity Sewers

1. The excavation to and preparation of the bottom of the trench shall be in accordance with these Specifications covering trenching, excavation, bedding and backfill.
2. The pipe shall be laid on firmly compacted bedding material throughout its entire length (except for such portion of the length as required to make a joint); and no blocking up with wood, rock, or other materials will be permitted.
3. No load from adjacent spigot shall be transmitted to the bell and the full annular joint space shall be maintained.
4. After the pipe has been securely anchored by placement of backfill material, along the sides and top, and the joint has been made, the bell holes shall be filled with approved bedding material, and tamping shall proceed as described herein.
5. Each piece of pipe, before being lowered into the trench, shall be inspected and cleaned, and spigots or hubs shall be clean and dry.
6. The pipe shall be laid to the lines and grades indicated, with hub ends upgrade; the first length at any starting point being firmly anchored to prevent movement; and shall have close fitting joints, and smoothness and continuity of invert.
7. As the pipe laying progresses, a suitable swab shall be pulled through the sewer in order to sweep out any accumulation of joint material, dirt, or other foreign material. All dirt, gravel, brick, joint material or other material is to be removed from the sewer as the work progresses and thereafter care shall be taken to prevent any entry of such material into the sewer. A final cleaning shall be made if necessary.
8. Whenever the pipe laying is discontinued the unfinished end is to be protected against displacement or other injury and securely closed with a tight fitting plug. When the Contractor resumes the work at this point, the plug shall not be removed until the trench has been dewatered and all mud, silt, and other material cleared away so as to prevent entry of any water or material into the pipe.
9. Pipe shall be so laid that, when sighting from manhole to manhole in any section, the whole diameter of the pipe shall be visible throughout the section. Any section failing to meet this specification or in which sags, humps, breaks, misalignment or other defects are detected shall be uncovered and defective section of pipe shall be corrected at the expense of the Contractor.
10. No more than one change from standard strength pipe to extra strength pipe may be made in any manhole section (between manholes); and extra strength pipe shall comprise upstream portion of the section.
11. No joint shall be covered until it has been reviewed by the Engineer.
12. Approved backfilling material shall be backfilled in layers of 4 inches maximum thickness; distributed uniformly and evenly on both sides of the pipe; and shall be thoroughly and carefully compacted in this manner to level one foot above the top of the pipe.
13. Thereafter, the backfilling operation shall be conducted as described in these Specifications.
14. No pipe shall be laid with water in trench not shall joining operations be undertaken unless water is kept below the bedding plane and below the socket or hub.

15. The Contractor shall notify the Engineer in advance of the time place, and date of arrival of pipe shipments.

    a. The pipe shall be inspected, as unloaded from the carrier.
    b. Rejected pipe shall be marked with paint, removed from the work area, and transported from the job site as quickly as possible.

F. Reinforced Concrete Gravity Sewers

1. The Contractor shall receive pipe at the job site from the manufacturer using equipment that will lift the pipe by steel slings supporting pipe in two places along the barrel.

    a. Handling of the pipe shall protect the integrity of all pipe delivered to the job site.
    b. No inward projecting lifting devices or loader bucket lifting equipment shall be allowed.

2. Excavation for the pipe and preparation of the trench bottom, including bedding to receive the pipe, shall be done in accordance with the applicable sections of these Specifications.

    a. In the preparation of the pipe bed the Contractor shall take into consideration any variation in thickness of the pipe shell; and the bed must be prepared to suit the particular piece of pipe to be lowered into place.
    b. Preparation of the compacted bed shall be such that when the pipe is lowered in place and pulled to secure full compressive pack of rubber joint ring, a smooth and uniform flow line on the specified grades will be secured.

3. All pipes shall be clean when lowered in the trench and shall be kept clean thereafter.

    a. The exposed ends of pipe in the trench shall be closed by suitable bulkheads at all times when pipe laying is not actually in progress.
    b. The Contractor shall install each joint of pipe with interior from line of pipe in the 12:00 o'clock position in the pipe trench.

4. Each section of pipe shall be securely anchored in place before the next adjoining pipe is laid and the joint between the sections is made.
5. After the joint has been pulled home (far enough to secure full compressive pack of gasket), treatment of the interior joint opening shall be as specified in the Reinforced Concrete Pipe Section and hereinbelow.

    a. Where the sewer is constructed in the vicinity of filling stations, oil, or gasoline bulk plants, or other such installations, or where evidence of leakage of hazardous products is noted, or suspected, the exterior annular space shall be completely packed with stiff Portland Cement mortar, 1:2 mix.
    b. Treatment of joint spaces, both interior and exterior, shall keep pace with pipe laying; and joint treatment operations shall not be more than four (4) joints behind the last pipe length laid in the trench in any continuous section of sewer.

6. No tools or equipment shall be used in the laying of the pipe that will damage the pipe or the lining.

    a. Under no conditions shall the Contractor use the trenching backhoe to secure the pipe in its proper plane or in its home position.
    b. The trenching equipment shall not be used to push home or to lower a joint of pipe into its proper position on grade by application of pressure on top of the pipe along its partial or full length.
    c. All pipe joints shall be brought home by use of proper designed equipment for the specific purpose.
    d. Pipe lengths that have received damage to shell, spigot, socket, or lining shall be replaced or repaired, according to the judgment of the Engineer.
    e. Such replacement or repair shall be at the Contractor's expense.

7. The Contractor must secure the following results with the pipe and joint used:

    a. A tight joint with gasket fully compressed and joint openings completely filled.
    b. A smooth and uniform interior section free from cracks, pits voids or crazing. Should hairline cracks or crazing at the spigot ends of pipe occur, the Contractor shall be required to coat the interior surface of the concrete pipe along the full circumference, for one foot either side of the defect with a coal tar epoxy. Crazing points or cracks shall be pointed or pitted to depth that will allow application of a water stopping plug material to stop flow of water. After water has stopped, the pipe shall be dried as approved by the Engineer. Surfaces shall be coated with coating similar or equal to two coats of Indurall Ruff Stuff 2100 coal tar epoxy to a total of 16 dry mill thickness.
    c. Watertightness after the trench has been backfilled and the water table has reached its normal level. The allowable infiltration shall not exceed limits as specified under Section 9.56.

3.2 BRACING OF PIPE AND FITTINGS

A. All pressure piping shall be braced against internal thrust by means of restrained joints and/or poured-in-placed concrete bracing where changes in direction occur or where branches from the line are located.

B. Braced underground piping shall be securely braced against movement with concrete thrust blocks and bearing against solid, undisturbed ground. Where solid or undisturbed ground cannot be obtained for bracing or where indicated on the Drawings restrained joint pipe and/or fitting shall be required.

C. Concrete braces shall be constructed in accordance with details shown on the Drawings; and shall be plain or reinforced as indicated or required.

D. Special bracing for particular locations identified on the Drawings and/or described herein shall be in accordance with details shown on the Drawings for the particular special brace and shall be complete with reinforcing steel and miscellaneous metal work.

E. Piping installed above ground in buildings, galleries, tunnels, piping trenches and chases shall be supported and braced as indicated on the Drawings and specified

herein. Unless otherwise specified, pipes shall be braced and supported by reinforced concrete piers or thrust blocks. The concrete used for construction of such piers or thrust blocks shall be anchored to slabs and/or walls by dowels and finished to match adjacent concrete surfaces or finished surfaces of adjacent walls or floors, whichever is applicable.

3.3 CONNECTIONS TO EXISTING SYSTEM

A. The Contractor shall make all connections to existing mains as indicated and as specified herein.

1. These connections shall be made at such times and in such manner as will keep to a minimum any interruptions of service or inconvenience to users of the system.
2. Connections to the existing system shall only be made after obtaining permission from the Owner specifically for each connection.
3. The Contractor shall be solely responsible for investigating the existing conditions (prior to bid if necessary), determining the requirements, and furnishing and installing all tools, equipment, labor and materials necessary for making the connection(s).

3.4 PIPELINE TESTING

A. The Contractor shall furnish all equipment, labor, materials, and supervision necessary to perform the tests required.

1. The Contractor shall bear the cost of testing, retesting, and any replacement work required (including all materials required).
2. The Contractor is solely responsible for observance of all safety regulations and for the maintenance of safe conditions during all testing work.
3. Should any pipe line, or any section of the line fail to meet the criteria established hereinbelow, all deficiencies shall be corrected and the testing repeated until the specified test results have been achieved.

B. All pipelines shall be tested in accordance with procedures and practices applicable to the various types and kinds of pipe and to the various sizes of pipe. The Contractor is reminded that personnel not experienced in testing procedures and practices, and particularly in air-testing of pipelines, should neither be allowed to conduct the test nor assist in the test procedures.

C. Testing Gravity Sewers

1. As heretofore stated in these Specifications, the Contractor shall prosecute the sewer construction work so as to secure the following:

a. Sewers uniformly bedded and backfilled.
b. Sewers having tight joints with gaskets fully compressed and joint openings (exceeding 1/4 inch) completely filled.
c. Sewers having smooth and uniform interior sections with respect to surfaces, grade, and alignment. Sewers shall have no “humps” or “dips” and absolutely no standing water will be acceptable in the line(s).

d. Sewer shall be watertight within the allowable limits.

2. The total quantity of infiltration into the sewer (including manholes) shall not exceed 50 gallons per mile of sewer per inch of inside diameter per 24 hours and in no case shall it exceed 2,500 gallons per mile per 24 hours. Regardless of the amount of infiltration leakage which occurs, the Contractor shall repair and correct any and all visible or audible leaks in any section of the sewer, manholes, or appurtenances.
3. In order that final testing of the sewers not be deferred until the sewers are operating under 'wet weather' and high water table conditions, and that surface restoration work can closely follow construction work, the Contractor shall employ the "low-pressure air testing procedure" in order to determine the probable acceptability of the sewers as reasonably watertight conduits (within the limits specified) when operating under 'wet weather' and high water table conditions.
4. Sewers of sizes up to and including 24" in diameter shall be tested by use of one of the following:

    a. Low-Pressure Air Test of Vitrified Clay Pipe Lines, ASTM C828, latest revision
    b. Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method, ASTM C 924, latest revision
    c. Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines, ASTM D969, latest revision

5. The use of Test Practices (a) or (b) shall not preclude acceptance by appropriate water infiltration or exfiltration testing such as Test Practice (c) hereinabove. The infiltration test shall not be used when the elevation of the groundwater table is less than two (2) feet above the top of the pipe throughout the entire length of the test section of the pipeline during the performance of the test.
6. Sewers of sizes 30" and larger will be examined for leaks and/or other interior deficiencies by making a complete interior examination of the pipelines.

    a. All visible leaks and deficiencies shall be repaired, and any and all leaks and other deficiencies appearing after all other leaks and other deficiencies have been repaired shall also be repaired.
    b. If the elevation of the ground water table, at the time of the last visual examination and measurement of leakage should have been less than two (2) feet over the top of the pipe throughout the entire length of the test section, the section shall then be tested for exfiltration by use of the testing practice as set forth in ASTM C 969, latest revision.

7. The "low-pressure air test" shall generally conform to the hereinafter outlined procedure, recommended by the National Clay Pipe Institute for testing sanitary sewers.

    a. Clean pipe to be tested. For small diameter sewers this may be done by "balling" the line, that is, utilizing water pressure for propelling a rubber ball through the sewer; and, in the case of larger diameter sewers, the Contractor may elect to employ interior cleaning crews. A wetted interior pipe surface will be advantageous in securing more consistent results.

b. Plug all open ends and pipe outlets with suitable test plugs, and brace each plug securely. Brace all plugged fittings and plugged service lines to prevent blow-out of plug.
c. If the pipe to be tested is subject to external pressure exerted by elevation of ground water table, the elevation of ground water table (with reference to invert of sewer) shall be determined. This may be done by either of the following methods: (1) Insert a pipe probe through backfill to elevation of invert by boring or jetting. Equip top end of probe with a bubbler head. Slowly pass air through bubbler head and probe. Read pressure from air gauge mounted on bubbler head. All base gage pressures specified for the test shall be increased by gage reading. Gage shall be low-pressure, wide range. (2) Install ½ inch diameter pipe through manhole wall at level approximately at top of sewer; turn down pipe outside of manhole to run to elevation of invert; and cap pipe inside of manhole. This should be done at the time when the manhole is constructed. When the line is to be tested remove cap, clear test pipe with compressed air, and connect clear plastic tube to test pipe. Start flow of water through pipe and tube, and read elevation of water in tube (with reference to invert of pipe). Divide reading by 2.31 and add resulting to invert of pipe). Divide reading by 2.31 and add resulting pressure (in psi) to add base gage pressures specified for the test. After all testing has been completed cap or plug test pipe at manhole wall.
d. Add air slowly to the plugged section of the sewer under test until the internal air pressure has been raised to 4.0 psig base plus any pressure allowance representing external head as determined under 3. hereinabove.
e. After the pre-set pressure (4.0 psig base + allowance) has been obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain the pre-set pressure, then close air supply valve.
f. When the pressure decreased to a gage reading equal to 3.5 psig base + allowance (such gage reading being termed stabilized pressure), start stopwatch. Determine time in seconds marking drop of 1.0 psig of internal air pressure.
g. Refer to the AIR TEST TABLE following this Section to determine minimum permissible pressure holding time in seconds for particular section of sewer being tested.

8. The Contractor shall furnish all labor, supervision, materials and equipment required for air testing of sewers.
9. As stated hereinabove, surface restoration shall closely follow construction work. It follows, therefore, that air testing of completed sections of sewer shall closely follow installation of the sewers in order that surface restoration work might be undertaken.
10. The Contractor shall be responsible for observance of all safety precautions and maintenance of safe conditions during air testing.

    a. These precautions shall include but not be limited to ensuring that personnel not experienced in air testing procedure not be allowed to conduct the air tests and that personnel are not allowed in the manholes at ends of test sections during tests.
    b. Pneumatic plugs shall be seal tested in pipe sections outside of trench before being used to plug sewers; and such test sections shall be internally pressurized to levels adequate to determine sealing efficiency of plugs.

c. Air supply lines to pneumatic plugs and to sealed section shall be equipped with pressure regulating sets.
d. Return line from sealed section shall be equipped with pressure gage to monitor pressure rise in sealed section.

AIR TEST TABLES*

MINIMUM HOLDING TIME IN SECONDS
REQUIRED FOR PRESSURE TO DROP FROM 3½ TO 2½ PSIG

PIPE SIZE

LF	4"	6"	8"	10"	12"	15"	18"	21"	24"	27"	30"	33"	36"	39"
25	4	10	18	28	40	62	89	121	158	200	248	299	356	418
50	9	20	35	55	79	124	178	243	317	401	495	599	713	837
75	13	30	53	83	119	186	267	364	475	601	743	898	1020	1105
100	18	40	70	110	158	248	356	485	634	765	851	935		
125	22	50	88	138	198	309	446	595	680					
150	26	59	106	165	238	371	510							
175	31	69	123	193	277	425								
200	35	79	141	220	317									
225	40	89	158	248	340									
250	44	99	176	275										
275	48	109	194	283										
300	53	119	211											
350	62	139	227											
400	70	158												
450	70	170												
500	88													
550	7													
600	106													

NOTE: TO BE USED WHEN TESTING ONE DIAMETER ONLY

*PUBLISHED BY NATIONAL CLAY PIPE INSTITUTE

D. Testing Sewage Force Mains

1. Pressure testing shall occur before backfilling over force main.

    a. Sewage force mains shall be pressure tested before backfilling around and over the joints, except in locations where traffic safety requires backfilling over a joint.
    b. Sections of force mains placed under test shall not exceed 1,200 feet in length and shall be isolated by valves or test plugs.
    c. Test pressure shall not be less than 80 psig; and the duration of test shall not be less than 8 hours.
    d. The allowable leakage shall not be greater than that determined by the following formula:

    L=9ND/3700 where,

        1) L=Allowable leakage in gallons per hour
        2) N=Number of joints in section of line tested
        3) D=Nominal diameter of pipe, in inches

2. Pressure testing after backfilling over force main.

    a. Backfilling over and around pipe joints before the force main is tested shall not be performed unless the permission of the Engineer is first secured.
    b. In the event the permission of the Engineer is secured and the sewage force main is backfilled throughout its entire length, the test pressure shall not be less than 80 psig in excess of the gage pressure indicated at the test point (after the line has been filled but before test pressure has been applied).
    c. The duration of the test shall not be less than 24 hours.
    d. The allowable leakage shall not be greater than that determined by the formula set forth hereinabove.

3. Whichever of the two procedures is followed, all visible leaks or leaks for which evidence is noted shall be repaired even though the measured leakage may be less than the allowable leakage as determined by the formula.

    a. Should the measured leakage exceed the allowable leakage as determined by the formula the line shall be repaired and retested until the measured leakage does not exceed the allowable leakage as determined by the formula.

4. The Contractor shall furnish all meters, gauges, plugs, pumps, water, labor, tools, materials, and equipment necessary for pressure testing the pipe line; and shall make all connections necessary to perform the test required. The Contractor shall bear the cost of testing, retesting, and any replacement work required (including all materials required).

E. Testing Plant Process Piping

1. Plant Process Piping shall include piping between plant treatment units which is not classified as gravity sewers or sewage forcemains.

2. Testing for process piping 12" or less in diameter shall be as specified hereinabove for sewage force mains.
3. Testing for process piping 14" and larger in diameter shall also be as specified for sewage forcemains with the exception that test pressure shall be 1.5 times the maximum working pressure but in no case shall the test pressure be less than 10 psi.

END OF SECTION 22 13 13

SECTION 23 05 00 - MECHANICAL GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The "General Conditions", "Supplementary Conditions", Statutory Declarations, Special Conditions and Division 1 of the specifications as written and referred to are adopted and made part of Division 23.

1.2 SUBMITTALS:

A. Submittals shall include the documents listed below:

1. Certificates of Inspection and Approval.

2. Qualifications of Superintendent.

3. Schedule of utility or service interruptions.

4. “Work Around” Plans for interrupting systems and providing temporary utilities.

5. Warranties.

6. List of proposed material manufacturers.

7. Coordination drawings.

8. Operating and Maintenance Manuals.

9. Record as-built prints.

10. Record electronic as-built drawings.

1.3 DESCRIPTION OF WORK:

A. Provide equipment, labor, material, etc., required to make a complete working installation as shown or as specified.

B. Equipment and materials used in the work shall be:

1. In accordance with the contract documents.

2. The best quality and grade for the use intended.

3. New and unused.

4. The manufacturer's latest standard or current model.

C. All equipment and method shall be installed and connected in accordance with the best engineering practices and in accordance with the manufacturer's recommendations.

1. Where the Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.

2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3. Contractor is responsible for dimensions and sizes of equipment. Inform Prime Engineer in writing of equipment differing from that shown.

D. Mechanical work includes, but is not limited to:

1. Obtain all permits and inspections including: building permits and health department permits.

2. Disconnect, remove and re-install mechanical services located on or crossing through contract limits, above or below grade, obstructing construction of project or conflicting with completed project or any applicable codes.

3. Maintain existing systems in operating condition to serve the continued operation for partial building occupancy spaces that must remain in operation during the construction period.

4. Modify, extend or tie-into existing mechanical services or systems.

5. Complete alterations and additions to ventilating systems.

6. Complete the ductwork.

7. Complete the casing and plenums.

8. Install devices furnished by the Temperature Controls sub-contractor.

9. Testing and Balancing will be by Independent Agency paid by this Contractor.

1.4 WORK IN EXISTING BUILDINGS:

A. Existing mechanical systems serving spaces involved in construction, or areas affected by construction, must be maintained and protected.

B. Contractor shall protect existing systems to keep them operational, or shall relocate the systems to keep them operational.

C. Temporary systems shall maintain the same level of capacity, protection, and safety provided by the permanent system being modified.

D. Coordinate routing of temporary systems and scheduling of interruptions with General Contractor , other trades, and Owner.

E. Disconnect and remove temporary systems when permanent systems are installed and running.

F. Contractor shall prepare drawings showing proposed methods of modifying existing systems (Work Around Plans) to maintain services to existing spaces during construction.

1.5 WORK NOT INCLUDED:

A. Finish painting of piping, ductwork or equipment.

B. Electrical wiring and conduits shown on the electrical drawings.

C. Asbestos removal.

1.6 RELATED WORK SPECIFIED ELSEWHERE:

A. Electrical: Division 26.

1.7 REQUIREMENTS OF REGULATORY AGENCIES:

A. Obtain and pay for all permits required for the work. Comply with all ordinances pertaining to work described herein.

B. Install the work under this Division in accordance with drawings and specifications and the standards and codes (latest edition) that apply to this work. In the event of a conflict, install work in accordance with the most stringent code requirements determined by Architect or Engineer.

C. Arrange, pay for and complete work to pass required tests by agencies having authority over work. Deliver to Prime Engineer Certificates of Inspection and approval issued by authorities.

1.8 QUALIFICATION OF CONTRACTOR:

A. Has completed minimum two projects same size and scope in past five (5) years.

B. This qualification applies to Sub-Contractors.

C. Use workmen experienced in their respective trade. Submit qualifications of Superintendent for review.

D. Owner reserves right to reject bid of any Contractor failing to meet these qualifications.

1.9 GENERAL JOB REQUIREMENTS:

A. Drawings and Specifications:

1. Work for the mechanical trades are shown on the drawings series M (HVAC).

2. Drawings and specifications are complementary. Work called for by one is binding as if called for by both.

3. Drawings are drawn to a small scale and are diagrammatic only. The drawings indicate size and general arrangement of equipment.

4. Do not scale drawings for exact locations. Refer to architectural drawings. Field measurements take precedence.

B. Provide necessary offsets, elbows and fittings as required to avoid conflict with equipment of other Divisions and to obtain proper headroom and clear passageways. This shall be done at no additional cost to the Owner.

C. Visit to Site/Work in other Division:

1. Examine not only the plans and specifications for this Division, but plans and specifications of the other Divisions of work and visit the site to become acquainted with existing conditions. Execution of Contract is evidence that Contractor has examined all drawings and specifications, and that all conditions which have a bearing in any way on the manner of installing the work in this Division are known. Later claims for labor and materials required due to difficulties encountered, which could have been foreseen had examination been made, will not be recognized.

D. Underground Utilities/Concealed Utilities:

1. All utilities and services, whether shown on the drawings or not, shall be suitably protected and maintained, and any damages thereto shall be promptly repaired. Owner shall be advised immediately of any damages sustained. If any extra expense is incurred due to the existence of buried utilities not shown on the drawings, or the location of which is not made known to the Contractor, the contract price shall be adjusted in accordance with the General Conditions. The Contractor shall advise the Owner three (3) days in advance of any operation which could possibly disrupt any underground utility. The Contractor shall utilize locator services to mark any underground utilities in the area he is working in, and shall make any other measure deemed necessary to avoid utility disruption.

E. Definitions:

1. Concealed: Materials or systems not visible. Work installed above a ceiling, furred behind a wall or enclosed in a chase.

2. Exposed: Materials or systems that are visible. Work installed in a

room without a ceiling. Work not enclosed by walls.

3. Provide: Furnish, install and make complete.

4. Install: Receive, unload, move into place, and make connections.

5. Work: Materials completely installed and connected.

6. ADC: Air Diffusion Council.

7. AGA: American Gas Association.

8. AMCA : Air Movement and Control Association.

9. ANSI: American National Standard Institute.

10. API: American Petroleum Institute.

11. ARI: American Refrigeration Institute.

12. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.

13. ASME: American Society of Mechanical Engineers.

14. ASTM: American Society of Testing Materials.

15. AWS : American Welding Society.

16. FM: Association of Factory Mutual Fire Insurance Company.

17. INT'L: Building Code, Gas Code, Mechanical Code, Plumbing Code.

18. MSS: Manufacturer's Standard Society of the Valve and Fittings Industry, Inc.

19. NEC: National Electrical Code.

20. NEMA: National Electrical Manufacturer's Association.

21. NFPA: National Fire Protection Association.

22. NRCA : National Roofing Contractors Association.

23. OSHA: Occupational Safety and Health Act.

24. SMACNA: Sheet Metal and Air Conditioning Contractors National Association.

25. UL: Underwriters Laboratories.

F. Workmanship, Warranty and Acceptance:

1. Work under this Division shall be first class with emphasis on neatness and workmanship.

2. Install work using competent mechanics, under supervision of foreman, all duly certified by local authorities. Installation subject to Architect's or Engineer's observation, final approval, and acceptance. Architect or Engineer may reject unsuitable work.

3. Furnish Prime Engineer written warranty, stating that if workmanship and/or materials executed under this Division is proven defective within one (1) year after final acceptance, such defects and other work damaged will be repaired and/or replaced.

4. In event that project is occupied or system placed in operation in several phases at Owner's request, warranty will begin on date each system or item of equipment is accepted by Owner.

G. Observations of Work and Demonstration of Operation:

1. When observations are scheduled, provide sufficient personnel to expedite removal of access doors, coverplates, manholes covers, etc.

2. Contractor to assist Architect or Engineer in demonstration of operation of new systems to satisfaction of Owner. Contractor to have manpower available for demonstration of systems where requested by Owner.

H. Materials and Substitutions:

1. All materials shall be new. All materials and equipment for which a UL Standard, an AGA approval, an AWWA standard, FM listing or ASME requirements is established, shall be so approved and labeled or stamped.

2. Wherever in these specifications products are specified by manufacturer's name, bids shall be based on the named products. Where more than one manufacturer's name is mentioned, the one first listed establishes the standard for that product. If the bidder desires to submit a product of a manufacturer other that listed first, it must be the equivalent of the one listed first.

3. The drawings are based on the use of products specified and listed first. If any revision in piping, conduit work, foundations, anchor bolts, connections, etc., is required by other named products or approved substitutions, it shall be the Contractor's responsibility to make such revisions at no additional expense to the Owner.

4. If any bidder desires to submit products of manufacturers not listed, he may submit a request for prior approval to the Engineer no later than 10 days prior to the bid date. If the Engineer decides to accept the manufacturers, they will be listed as "Approved" by written addendum.

5. If the manufacturers are not listed as approved either by addendum or in the specifications, they will not be accepted.

6. Submit to Prime Engineer a complete list of proposed material manufacturers. List does not preclude submission of shop drawings. Approval of manufacturer or list does not constitute approval of specific material or equipment.

I. Coordination Drawings:

1. Prepare coordination plan drawings. Drawings shall be drawn at not less than 1/4" equals 1 foot scale on architectural building background.

2. Drawings shall identify:

a. Structural elevations
b. Gravity piping elevations
c. Ductwork elevations
d. Piping elevations
e. Conduit (3" and larger) elevations
f. Equipment
g. Cable tray/bus duct elevations

J. Operating and Maintenance Manuals:

1. Provide maintenance and operating manuals bound in 8-1/2" x 11" hardback, three-post binders. Manuals shall contain written instructions for each system, shop drawings, schematic drawings, equipment catalog cuts, manufacturer's instructions, manufacturers warranties, and valve tag list.

2. Arrange information in the following sequence: title of job, Owner, address, date of submittal, name of Contractor, name of Engineer, index, shop drawings, operating instruction, Contractor's purchase order numbers, supplier's name and address, date of start-up of each piece of equipment and valve tag list.

3. Submit one (1) copy for review. Make required corrections, and submit two (2) record copies.

K. Record As-Built:

1. Provide Record as-builts at the completion of job. Keep set of prints on job and record day to day changes to Contract drawings with red pencil. Indicate actual location of piping, ductwork, valves, dampers, and equipment. Turn over prints to Prime Engineer at final observation.

2. Provide the following items for Owner at time of substantial completion:

a. Certificates of inspection and approval from authorities having jurisdiction.

b. Warranties.

c. Record as-built prints.

d. Record as-built electronic plans in auto cad format.

e. Operating and Maintenance Manuals - Printed Binders (3 copies).

f. Operating and Maintenance Manuals - PDF Files on CD-Rom (1 Disk).

g. Spare Parts (furnish receipt).

h. Affidavit of Owner Instruction (1 copy).

i. Release of Liens.

1.10 PROTECTION AND STORAGE:

A. Provide warning lights, bracing, shoring, rails, guards and covers necessary to prevent damage or injury.

B. Protect all equipment and materials, from damage by weather, entrance of water or dirt. Cap open piping, use plastic covers made for that purpose. Do not use rags or construction debris.

C. Avoid damage to materials and equipment in place. Repair, or remove and replace damaged work and materials.

D. Protect all surfaces from weld spatter, solder and cutting oil.

E. Deliver equipment and materials to job site in original, unopened, labeled container. Store to prevent damage and injury. Store ferrous materials to prevent rusting. Store finished materials and equipment to prevent staining and discoloring. Store materials affected by condensation in warm dry areas. Provide heaters. Storage space on site and in building designated by Owner/Prime Engineer.

END OF SECTION 23 05 00

SECTION 23 05 05 - MECHANICAL SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY:

A. This Section includes procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

1.3 DEFINITIONS:

A. Action Submittals: Written and graphic information that requires Engineer's through the Prime Engineer's responsive action.

1.4 SUBMITTAL PROCEDURES:

A. General: Electronic copies of CAD Drawings of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals for a fee.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Submittals Schedule: Comply with requirements in Division 1 for list of submittals and time requirements for scheduled performance of related construction activities.

D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.

2. Concurrent Review: Where concurrent review of submittals by other

consultants, Owner, or other parties is required, allow 21 days for initial review of each submittal.

a. Division 23 equipment requiring electrical connection

3. If intermediate submittal is necessary, process it in same manner as initial submittal.

4. Allow 15 days for processing each resubmittal.

5. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.

E. Identification: Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.

2. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.

3. Include the following information on label for processing and recording action taken:

a. Project name.
b. Date.
c. Name and address of Architect.
d. Name and address of Contractor.
e. Name and address of Sub-Contractor.
f. Name and address of supplier.
g. Name of manufacturer.
h. Unique identifier, including revision number.
i. Number and title of appropriate Specification Section.
j. Drawing number and detail references, as appropriate.
k. Other necessary identification.

F. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.

G. Number of Copies:

1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.

2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.

H. Transmittal: Package submittals into binders or booklets.

1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.

2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.

3. Transmittal Form: Provide locations on form for the following information:

   a. Project name.
   b. Date.
   c. Destination (To:).
   d. Source (From:).
   e. Names of subcontractor, manufacturer, and supplier.
   f. Category and type of submittal.
   g. Submittal purpose and description.
   h. Submittal and transmittal distribution record.
   i. Remarks.
   j. Signature of transmitter.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

A. General: Prepare and submit Submittals required by individual Specification Sections.

1. Number of Copies: Submit 6 copies of each submittal, unless otherwise indicated. Engineer will return 4 copies. Mark up and retain one returned copy as a Project Record Document.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:

    a. Manufacturer's written recommendations.
    b. Manufacturer's product specifications.
    c. Manufacturer's installation instructions.
    d. Standard color charts.
    e. Manufacturer's catalog cuts.
    f. Wiring diagrams showing factory-installed wiring.
    g. Printed performance curves.
    h. Operational range diagrams.
    i. Mill reports.
    j. Standard product operating and maintenance manuals.
    k. Compliance with recognized trade association standards.
    l. Compliance with recognized testing agency standards.
    m. Application of testing agency labels and seals.
    n. Notation of coordination requirements.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Include the following information, as applicable:

    a. Dimensions.
    b. Identification of products.
    c. Fabrication and installation drawings.
    d. Roughing-in and setting diagrams.
    e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
    f. Shopwork manufacturing instructions.
    g. Templates and patterns.
    h. Schedules.
    i. Design calculations.
    j. Compliance with specified standards.
    k. Notation of coordination requirements.
    l. Notation of dimensions established by field measurement.

2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.

3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-½ by 11 inches, but no larger than 30 by 40 inches.

4. Number of Copies: Submit one correctable, translucent, reproducible print and one blue- or black-line print of each submittal. Engineer through Architect will return the reproducible print.

5. Number of Copies: Submit 6 prints where prints are required for operation and maintenance manuals. Engineer and Architect will retain one print each; remainder will be returned.

D. Coordination Drawings:

1. Coordination drawings shall be prepared on sheets the same size as the contract drawings.

2. Number of submittal copies: Submit one reproducible copy of the coordination drawing. Engineer through Architect will return the reproducible.

3. Number of copies after approval: After approval, submit one black line copy of the coordination drawings for the record copy.

4. Refer to Division One for additional coordination requirements.

PART 3 - EXECUTION

3.1 GENERAL:

A. Review of submittals by Engineer is to insure general quality conformance with the contract documents. The contractor assumes all responsibility for dimensions, quantities, conditions that pertain to the fabrication and installation, and for processes and techniques of construction.

B. Review of submittals or shop drawings by Engineer does not relieve Contractor of responsibility for errors or omissions during the submittal process. Submittal review does not relieve the contractor of any obligation in the contract documents.

C. Products of one manufacturer have been scheduled or specified as the basis of design. Any modifications to ductwork, piping, wiring, building structure, etc. that results from the use of any other products shall be coordinated by this contractor with all trades prior to delivery of approved product from the manufacturer. All modifications required shall be performed without incurring any additional cost to the Contract. Contractor shall document all modifications on the as-built record plans.

3.2 CONTRACTOR'S REVIEW:

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.3 ENGINEER'S ACTION:

A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:

1. Approved - Fabrication/Installation may be undertaken.
2. Approved as Noted - Fabrication/Installation may be undertaken.
3. Revise and Resubmit - Fabrication/Installation MAY NOT be undertaken. In resubmitting, limit corrections to items marked.
4. Rejected - Fabrication/Installation MAY NOT be undertaken. In resubmitting, limit corrections to items marked.

C. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

3.4 SUBMITTAL SCHEDULE:

A. See Attachment.

END OF SECTION 23 05 05

SECTION 23 05 10 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Provide equipment, labor, materials, etc. required to make a complete working installation as shown or as specified.

1.2 SUBMITTALS:

A. Provide submittals for:

1. Miscellaneous stainless steel
2. Equipment identification

PART 2 - PRODUCTS

2.1 MISCELLANEOUS STAINLESS STEEL:

A. ASTM A-276 Structural Stainless Steel

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING:

A. Contractor shall be responsible for cutting and patching.

B. Cut walls, floors, ceilings, partitions, etc., required for the installation of this work in a neat and careful manner. Core drill for pipe sleeves and other openings through floors and walls. Sawcut larger openings. Cutting shall be kept to a minimum. Obtain approval of Prime Engineer before cutting or drilling.

C. Replace or repair ductwork, conduit, piping, etc., that is cut. Patch around opening cut by this Contractor or provided by others for him. Patching shall be done by an approved qualified contractor, but shall be paid for by this Contractor. Finished patching shall retain fire and smoke ratings of the assembly and shall match surrounding finish.

3.2 ANCHORS:

A. Mount all equipment, brackets, hangers, anchors, etc. to safely resist the vibration or thrust forces and support the unit's weight. Anchors, brackets, etc. shall be structural stainless steel.

3.3 EQUIPMENT IDENTIFICATION:

A. Identify each piece of equipment with a 1/8 inch thick engraved melamine plastic laminate nameplate. Letters shall be ½ inch high standard style. Names, abbreviations, and numbering shall agree with the corresponding equipment designations shown on the drawings. Use black letters cut in a white background

for all equipment on standard electrical power and use white letters cut in a red background for all equipment on emergency power. (Coordinate with Division 26 "Electrical" Contractor).

B. Fasten nameplates to equipment in a conspicuous location using contact epoxy adhesive.

END OF SECTION 23 05 10

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing (T/A/B) as required to meet design specifications, plus recording and reporting the results.

1.2 SUMMARY:

A. Prior to acceptance and before final inspection, test and balance the air systems as listed herein and as specified hereinafter and submit reports as specified hereinafter.

B. The mechanical contractor has numerous responsibilities associated with the test and balance, it is imperative that the test and balance contractor coordinate these responsibilities with them.

C. Test, adjust, and balance the following mechanical systems:

1. Supply air systems, all pressure ranges;

2. Return air systems;

3. Exhaust air systems;

4. Verify temperature control system operation.

D. This Section does not include:

1. Testing boilers and pressure vessels for compliance with safety codes;

2. Specifications for materials for patching mechanical systems;

3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.

1.3 CODES AND STANDARDS:

A. Applicable publications: The following publications form a part of this specification, to the extent that they represent minimum standards. Where this specification exceeds these standards, this specification shall be followed.

B. Associated Air Balance Council (AABC) National Standards or Field Measurement and Instrumentation, latest edition.

C. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook - Fundamentals, latest edition.

D. Chapters on Testing, Adjusting, and Balancing of Environmental Systems and Related Subjects, ASHRAE Handbook - Systems, latest edition.

E. National Environmental Balancing Bureau (NEBB)

F. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, latest edition.

G. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) HVAC System - Testing, Adjusting and Balancing, latest edition.

1.4 QUALIFICATIONS FOR TEST AND BALANCE CONTRACTOR:

A. The test and balance contractor shall be an independent contractor that regularly performs air systems testing and balancing. Minimum qualifications for acceptance shall be general membership in NEBB or AABC, except that affiliation with manufacturers, installing, contractors, or engineering firms may not preclude acceptance.

B. Supervisor directly in charge of the air testing and balancing work shall be a registered professional engineer, in the state where the project is located, with not less than five (5) years experience in the mechanical contracting industry and not less than two (2) years experience in testing and balancing of heating, ventilating, and air conditioning systems. The supervisor shall stamp the title page of the test and balance report with his professional engineer's stamp.

C. The supervisor and the lead test and balance mechanic shall be certified as test and balance technicians by one or more of the following groups, AABC, NEBB, SMACNA, ASHRAE, or the Sheet Metal Workers Union.

D. Instrument calibration: Calibrate all instruments required for air and water balancing within a period of six months prior to their use on this project, per NEBB or AABC standards and the instrument manufacturers.

E. Tests shall be conducted in presence of the Architect-Engineer and/or the Owner or their representatives. Notify the Architect-Engineer and Owner in writing five working days before the start of testing.

1.5 DEFINITIONS:

A. Adjust: To regulate flow rate and air patterns at the terminal equipment, such as to increase or reduce fan speeds or adjust a damper.

B. Balance: To proportion flows within the distribution system, including sub-mains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow,

whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

G. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

H. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

I. Test: A procedure to determine quantitative performance of a system or equipment.

J. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

K. AABC: Associated Air Balance Council.

L. AMCA: Air Movement and Control Association.

M. ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

N. NEBB: National Environmental Balancing Bureau.

O. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.6 SUBMITTALS:

A. Certified Testing, Adjusting, and Balancing Reports: Submit 6 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

1.7 QUALITY ASSURANCE:

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports

2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

C. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing Agent's standard forms approved by the Engineer.

D. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.

E. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.8 COORDINATION:

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 THE MECHANICAL CONTRACTOR’S RESPONSIBILITIES:

A. Furnish the test and balance contractor one complete set of accepted equipment data and one complete set of accepted mechanical shop drawings.

B. The mechanical contractor shall be responsible for advising the test and balance contractor of any change(s) made to the system(s) during the construction process.

C. Mechanical contractor shall provide drawings, specifications, shop drawings, control diagrams, etc. detailing the change(s) to the test and balance contractor.

D. Replace and/or install pulleys, belts and dampers as required for the correct balance as directed by the test and balance contractor.

E. Allocate time in the construction schedule for test and balance procedure.

F. Assist the test and balance contractor in coordinating work with the other trades.

G. Place all systems and necessary allied devices required, and only those

required, for each working day of the testing and balancing procedures into "Full Call" operation. At the completion of the testing and balancing procedures for the day, the mechanical contractor shall return the systems to normal operation or shut them down.

H. Prepare the air side system for testing and balancing as follows, (all new and existing devices are included):

1. Mechanically check all rotating air devices, to insure that the devices are capable of operation under normal design modes and have correct rotation and the related automatic controls are functional and calibrated.

2. All balancing, splitter, volume and control dampers shall be in their respective neutral position or fully open. All locking devices shall be functional and secured.

3. All air distribution inlet and outlet devices (i.e., grilles, registers, diffusers, and etc.) shall be fully open. All locking devices shall be functional and secured.

4. All automatic controls (i.e., direct digital, electronic, electric, pneumatic, and/or any combination thereof) shall be mechanically and electrically checked and be available to operate under design conditions.

5. Air control locking devices (i.e., control rods, quadrants, and etc.) shall be permanently marked to represent the true position of their respective control surfaces. The locking devices markings shall be inconspicuous in occupied areas.

6. Install new air filters before the start of testing and as directed by the test and balance contractor in order to meet design conditions of the air handling devices. Provide air control devices, such as balancing dampers, as per the drawings and specifications, and as directed by the test and balance contractor in order to obtain the proper balance conditions.

3.2 EXAMINATION:

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.

2. Verify that balancing devices are installed as required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine equipment performance data, including fan curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

E. Examine system and equipment test reports.

F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

G. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

H. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.3 PREPARATION:

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.

2. Automatic temperature-control systems are operational.

3. Equipment and duct access doors are securely closed.

4. Balance and fire dampers are open.

5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

6. Windows and doors can be closed so design conditions for system operations can be met.

3.4 GENERAL TESTING AND BALANCING PROCEDURES:

A. Perform testing and balancing procedures on each system according to the procedures contained in 2019 ASHRAE Applications Handbook Chapter 39, AABC or NEBB national standards and this Section.

B. Cut insulation, ducts,, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, fan-speed-control levers, and similar controls and devices, to show final settings.

3.5 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES:

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

3.6 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES:

A. Adjust fans to deliver total design airflow within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. The Contractor shall make recommended corrective changes to align design and actual conditions.

5. Adjust fan speed higher or lower than design, as necessary to attain design flow and pressure values. The Contractor shall make required replacements or adjustments to pulleys and belts to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower. The Contractor shall replace any equipment that does not perform as stated in the submitted product literature.

B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

2. Where sufficient space in sub-mains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

3. Remeasure each sub-main and branch duct, after all have been adjusted. Continue to adjust sub-mains and branch ducts to design airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 TOLERANCES:

A. Set HVAC system airflow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.

2. Air Outlets and Inlets: 0 to minus 10 percent.

3.8 INITIAL REPORTING:

A. Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 FINAL REPORT:

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems. All data may not apply to all project devices, provide data as applicable to the piece of equipment being tested.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Fan curves.

2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.

4. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.

2. Name and address of testing, adjusting, and balancing Agent.

3. Project name.

4. Project location.

5. Engineer's name and address.

6. Contractor's name and address.

7. Report date.

8. Signature of testing, adjusting, and balancing Agent who certifies the report.

9. Summary of contents, including the following:

   a. Design versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.

10. Nomenclature sheets for each item of equipment.

11. Data for terminal units, including manufacturer, type size, and fittings.

12. Notes to explain why certain final data in the body of reports vary from design values.

13. Test conditions for fans performance forms, including the following:

    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.

c. Cooling coil, wet- and dry-bulb conditions.
d. Fan drive settings, including settings and percentage of maximum pitch diameter.
e. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.

2. Duct, outlet, and inlet sizes.

3. Terminal units.

4. Balancing stations.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.

2. Motor Data: Include the following:

a. Horsepower and rpm.
b. Volts, phase, and hertz.
c. Full-load amperage and service factor.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Outside airflow in cfm.
g. Return airflow in cfm.
h. Outside-air damper position.
i. Return-air damper position.

G. Fan Test Reports: For supply, exhaust, and ventilation fans, include the following:

1. Fan Data: Include the following:

a. System identification.
b. Location.
c. Make and type.
d. Sheave make, size in mm, and bore.

e. Sheave dimensions, center-to-center and amount of adjustments in inches.

2. Motor Data: Include the following:

a. Horsepower and rpm.
b. Volts, phase, and hertz.
c. Full-load amperage and service factor.
d. Sheave make, size in inches, and bore.
e. Sheave dimensions, center-to-center and amount of adjustments in inches.
f. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area (sq. ft).
g. Design airflow rate in cfm.
h. Design velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports: For terminal units, include the following:

1. Unit Data: Include the following:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.10 ADDITIONAL TESTS:

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 23 05 93

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SECTION 23 06 00 - LOUVERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. The work required under this section includes all work necessary for a complete installation of louvers.

1.2 CODES AND STANDARDS:

A. Provide louvers with performance requirements per Air Movement and Control Association (AMCA) Standard 500.

1.3 QUALITY ASSURANCE:

A. Take field measurements to verify size, location and placement of louver units before fabrication.

B. Coordinate field measurements and Shop Drawings with fabrication and shop assembly; minimize field adjustments or assembly, splicing, and mechanical joints. Disassemble in shop only as necessary for shipping. Clearly mark units for reassembly and installation.

1.4 SUBMITTALS:

A. Manufacturer's complete and current Product Data, including test data certifying compliance.

B. Submit product finish color to Engineer for written approval before ordering.

C. Shop Drawings, include plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joining and other information showing compliance with requirements.

D. Technical Data. Provide performance capacity data for louvers at area, velocity, etc., of the scheduled louvers and provide same data for a standard 48" x 48" size louver at 1000 fpm velocities.

PART 2 - PRODUCTS

2.1 GENERAL:

A. See Drawings for sizes and configurations. Provide louvers and accessories as shown and required for optimum performance with respect to airflow, water penetration, air leakage, strength, durability and uniform appearance.

B. Fastenings to be same material as items fastened. Fasteners for exterior may be hot-dip galvanized or stainless steel. Provide types gauges and lengths to suit application shown. Use Phillips flat-head machine screws for exposed fasteners.

C. Anchors and inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

D. Ensure compatibility of metals with adjacent materials. Prevent galvanic action due to contact between dissimilar metals.

E. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation, including application of sealants in joints between louvers and adjoining work.

F. Include supports, anchorages, and accessories required for complete assembly.

G. Provide vertical mullions of type and at spacings required but not further apart than recommended by manufacturer. At horizontal joints between louver units, provide horizontal mullions except where continuous vertical assemblies are indicated.

H. Provide sill extensions and loose sills made of same material as louvers for drainage to exterior and to prevent water penetrating to interior.

I. Weld frame members to one another and to stationary louver blades, except where field-bolted connections between frame members are necessary because of louver size. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

2.2 STATIONARY EXTRUDED ALUMINUM LOUVERS:

A. Fabrication: Extruded Aluminum stationary horizontal chevron louver style.

1. Design:

a. Double drainable blades shall be contained within the frame with double downspouts in jambs and mullions. Louver design shall limit span between visible mullions to 120 inches.

2. Frame:

a. Frame Depth: 5 inches.
b. Wall Thickness: 0.081 inch, nominal.
c. Material: Extruded aluminum, Alloy 6063-T6.

3. Blades:

a. Style: Sightproof, double drainable, horizontally mounted on 2 inches centers, nominal.
b. Material: Extruded aluminum, Alloy 6063-T6.
c. Wall Thickness: 0.063 inch (1.6 mm), nominal.

B. Performance Data:

1. Based on testing 48 inches x 48 inches size unit in accordance with AMCA 500-L.

2. Free Area: 44 percent, nominal.

3. Free Area Size: 6.99 square feet.

4. Maximum Recommended Air Flow through Free Area: 1,361 fpm.

5. Air Flow: 9514 cfm.

6. Maximum Pressure Drop (at 1361 feet per minute): 0.20 inches w.g.

C. Wind Driven Water Penetration Performance:

1. Based on testing 39 inches x 39 inches core area, 41 inches x 44 inches nominal size unit in accordance with AMCA 500-L.

2. Wind Velocity: 29 mph.

a. Rainfall Rate: 3 inches/hour.
b. Free Area Velocity: 1361 feet per minute.
c. Water Resistance Effectiveness: 99.7% (AMCA Class A).

3. Wind Velocity: 50 mph.

a. Rainfall Rate: 8 inches/hour.
b. Free Area Velocity: 778 feet per minute.
c. Water Resistance Effectiveness: 99.0% (AMCA Class A).

D. Design Windload:

1. Louver shall be reinforced for wind pressure forces equal to 30 psf.

E. Color:

1. Dark Bronze

F. Manufacturers:

1. Basis of design is Ruskin Model EME520DD. Greenheck, Construction Specialties, and Airolite are approved equals.

PART 3 - EXECUTION

3.1 PREPARATION:

A. Coordinate installation drawings, diagrams, templates, instructions and directions for installation of anchorages to be embedded in concrete or masonry construction. Coordinate delivery of such items to the project site.

3.2 INSTALLATION:

A. Locate and place louver units plumb, level and in proper alignment with adjacent work.

B. Use concealed anchors and fasteners only, unless specifically shown otherwise on drawings.

C. Provide washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.

D. Form tight joints with exposed connections accurately fitted. Provide reveals and openings for sealants and joints fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering and grinding. Restore finishes so there is no evidence of corrective work. Return items which cannot be refinished in the field to shop, make required alterations, and refinish entire unit, or provide new units, at Contractor's option.

END OF SECTION 23 06 00

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. All work covered in this section consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to piping, equipment, and ductwork.

1.2 DEFINITIONS:

A. Exposed piping and ductwork is that which can be seen when the building is complete without opening or removing access door panels, or ceilings tiles. This also includes all mechanical equipment rooms and pipe tunnels.

B. Concealed piping and ductwork are those elements above ceilings, in chases, interstitial space and pipe spaces. Other piping and ductwork is considered to be exposed.

C. Exterior piping and ductwork is that which is exposed to the weather and/or outside the building envelope. Piping and ductwork protected by overhangs, areaways, etc., exterior to the building envelope are considered exterior.

D. ASJ: All service jacket, white finish facing or jacket.

E. Air conditioned space: Space directly supplied with heated or cooled air.

F. Cold: Equipment, ductwork or piping handling media at design temperature of 60 degrees F or below.

G. FRK: Foil reinforced kraft facing.

H. FSK: Foil-scrim-kraft facing.

I. Hot: Ductwork handling air at design temperature above 60 degrees F; equipment or piping handling media above 105 degrees F.

J. Pcf: Density, pounds per cubic foot.

K. Runout: Branch pipe connection up to one inch nominal size to a one terminal piece of equipment (fan coil, terminal box).

L. Thermal conductance: Heat flow rate through materials.

1. Flat surface: BTU per hour per square foot.

2. Pipe or cylinder: BTU per hour per linear foot.

3. Thermal conductivity (k): BTU per inch thickness, per hour, per square foot, per degree Fahrenheit temperature difference.

1.3 QUALITY ASSURANCE:

A. Products of the manufacturers, herein, will be acceptable for use for the specific functions noted. All materials shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such materials in either the wet or dry state.

B. Materials shall be applied subject to their temperature limits. Any methods of application of insulation materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.

C. Insulation shall be applied by experienced workers regularly employed for this type work.

1.4 RATING:

A. All insulation shall have composite surface burning characteristic rating as tested by ASTM E 84, UL 723, or NFPA 255 not exceeding:

Flame Spread	25
Smoke Developed	50

B. Composite shall include insulation, jacketing and adhesive used to secure jacketing or facing. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement, tape and cloth shall have the same component rating as specified above.

1.5 STANDARDS:

A. International Energy Conservation Code.

B. ANSI/ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-rise Residential Buildings.

C. Midwest Insulation Contractors Association “Commercial and Industrial Insulation Standards” - Third Edition.

1.6 SUBMITTALS:

A. Submittals shall include all materials used, including:

1. Insulation
2. Jacketing
3. Tapes
4. Hardware
5. Mastics
6. Adhesives

B. Submittals shall be formatted to include a list of materials for each service:

C. Submittals shall use pages from Midwest Insulation Contractors Association - “Commercial and Industrial Insulation Standards” for defining how insulation

materials will be applied.

PART 2 - PRODUCTS

2.1 GLASS FIBER INSULATION:

A. Ductwork (Insulation):

1. Insulation shall be 250 deg. F rated as manufactured by Owens Corning, Manville, Knauf, or Certainteed.

2. Duct Wrap: 1.0 PCF with aluminum or FRK facing, having a maximum vapor transmission of .02 perms.

3. Insulation Board: 3 PCF with FRK facing.

2.2 FINISHES:

A. Metal jacketing, smooth .016 in. thick, type T 3003 aluminum with laminated moisture barrier. Jacketing shall be Childers, aluminum roll jacketing with Polykraft moisture barrier.

2.3 MISCELLANEOUS:

A. Adhesives:

1. Glass & Mineral Fiber - Foster 85-20 / Vimasco 795.

2. Cellular Glass - Pittcote 300 / Childers CP-30.

B. Mastic (Weather Barrier):

1. Foster 35-00 Mastic / Vimasco.

2. Childers Vi-Cryl CP10/11.

3. Vimasco WC-5.

C. Coatings:

1. Foster - Monolar Coating / Vimasco

2. Foster Sealfas 30-36 / Vimasco

3. Foster Tite-Fit 30-56 / Vimasco

4. Pittcote 300

D. Vapor Barrier Sealant: Foster Flextra 95-50

E. FSK tape 3 in. wide, equal to Nashua FSK.

F. Insulpins

G. Roll on Corner bead (2 in. x 2 in., 26 ga. galvanized steel).

H. Fiber reinforced tape - Nashua 357, or 398.

I. Insulation protection shields - Grinnell fig 167.

J. Rigid insulation inserts - Hamfab.

K. Reinforcing Cloth - Vimasco, Elastafab 894, conforming to ASTM D1668.

L. Bands - .020 in., aluminum, ½ in. wide, embossed continuously with the legend "No Asbestos".

M. Hexagonal Wire Netting - One inch mesh, 22 ga. galvanized steel.

PART 3 - EXECUTION

3.1 GENERAL:

A. Insulation shall be applied to clean and dry surfaces after tests and approvals required by this specification have been completed.

B. On cold surfaces where a vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.

C. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

D. All duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where firestop or firesafing materials are required.

E. Insulate items mounted in ductwork with the same thickness of insulation as specified for ductwork.

F. Standing seams and other projections in ductwork or casings shall have insulation applied so that at least ½" of insulation will cover such projections.

G. Ductwork covered with metal jacketing systems shall have the joints made to shed water. Laps shall be positioned in the bottom quadrant.

3.2 HVAC SYSTEMS:

A. Interior Ductwork:

1. Apply jacketed ductwrap to all concealed ductwork providing conditioned air, or outside air.

2. Pull insulation snug, but do not compress insulation more than 1/4 inch.

3. Secure ductwrap insulation to ductwork using adhesive. Secure insulation on bottom on sides of horizontal ductwork and all sides of vertical ductwork with insulpins welded to duct on 12 to 18 inch centers and with clips slipped over the pins. Apply clips without compressing insulation. Make joints by lapping the facing a minimum of 2 inch and stapling with T-5 flared staples. Vapor - seal with Childers CP-30 Low Odor at all staples, clip locations and other penetrations. Seal joints with 3 inch wide FSK tape.

4. See schedule at end of this section for insulation thicknesses.

B. Exterior Ductwork:

1. Apply insulation board with FRK facing to all exterior ductwork.

2. Secure insulation with insulpins (all surfaces) welded to duct on 12 to 18 in. centers and with clips slipped over pins. Seams and joints shall be vapor sealed with 3 in. wide FSK tape. Corners and edges of ductwork shall be reinforced with roll-on corner bead.

3. Seal all break and punctures with vapor barrier sealant and FSK tape.

4. See schedule at end of this section for insulation thicknesses.

5. Exterior ductwork shall be covered with aluminum jacketing. Covering shall be hemmed, and flanged. Secure with self tapping screws on eight inch centers. Do not puncture vapor barrier. Completely caulk and weather seal all seams and screw locations.

MINIMUM DUCT INSULATION REQUIREMENTS		
	UNCONDITIONED SPACES	INSIDE CONDITIONED SPACES
SUPPLY DUCT		
Duct wrap	R-8	R-6
Insulation board	R-8	--
RETURN DUCT		
Duct wrap	R-8	R-6
Insulation board	R-8	--

END OF SECTION 23 07 00

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23 20 10 - GAS PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Provide complete installation of gas piping from the “point of delivery” noted on plans up to and including connection to all gas-fired equipment.

1.2 CODES AND STANDARDS:

A. International Plumbing Code

B. International Gas Code

C. NFPA 54 - Fuel Gas Code/ANSI - Z223.1

D. American National Standards Institute (ANSI)

E. CSA America

F. American Society of Mechanical Engineers (AMSE)

G. American Society for Testing and Materials (ASTM)

1.3 SUBMITTALS:

A. Submit manufacturer's literature on all materials and equipment including:

1. Pipe
2. Pipe Coating
3. Anodes
4. Valves
5. Flexible Connectors
6. Fittings
7. Regulators
8. Relief Valves
9. Gauges

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS:

A. Pipe/Tubing:

1. Steel Pipe: ASTM A53 Grade A or B, Type F, ERW or seamless. Schedule 40.

2. ASTM A106 seamless. Schedule 40.

3. Tubing (steel) ASTM A539.

4. Plastic Pipe ASTM D2513 polyethylene. Drisco pipe 6500 or prior approved equal.

B. Fittings:

1. Welded (Steel):

a. Welding fittings shall be carbon steel butt welding type conforming to ASTM-234. Elbows shall be long radius type. Welding tees shall be used on branch connections equal to or greater than ½ the diameter of the main run. Fittings shall be Ladish, Tube-Turn or Weldband.

b. Carbon steel reinforced branch, welding fittings up to 3 inches, but not greater than ½ the diameter of the main run may be used. Fittings shall be Bonney Forge or Phoenix Forging.

2. Threaded (Malleable, Iron):

a. Screwed fittings shall be malleable Iron ASTM A-197 class 150 conforming to ANSI B16.3. Dimensions conforming to Federal Spec WW-P-521. Fittings shall be Grinnell, Flagg or Stockham.

2.2 UNIONS (DIELECTRIC):

A. Class 250 malleable, screwed ASTM A-197.

2.3 VALVES:

A. General

1. Valves shall be of an approved type and constructed of materials compatible with the piping.

2. Valves shall comply with ANSI Z21.15, CSA requirement 3-88, ASME B16.44, and ASME B16.33 as noted in International Fuel Gas Code.

B. 2 ½ Inches and Larger:

1. Plug Valve - Class 125 flanged cast iron ASTM A126 conforming to ANSI B16.1.

2.4 PIPE COATING:

A. X-Tru Coat or prior approved equal including joints and fittings.

2.5 PRESSURE REGULATORS/PRESSURE GAUGES:

A. Cast iron or aluminum body and spring case with stainless steel valve steam, seat ring and valve plug, plated steel springs, neoprene diaphragm and gaskets and TFE disc. Regulating valves shall be sized for the flow indicated and for inlet and outlet pressures indicated. Outlet pressure shall be maintained under the design flow

condition and at no flow. Regulating valves two psi and below shall have leak limiting devices. Regulating valves over two psi shall be vented full size to outside of the building. Other regulating valves requiring access to the atmosphere shall be equipped with vent piping leading to outside. Provide a pressure relief valve if the regulator connection size exceeds two-inches. Regulating valves shall be Fisher, Maxitrol or prior approved equal meeting ANSI Z21.18 and ANSI Z21.80.

B. Pressure Gauge:

1. For medium pressure gas; 0-5 psi range. For low pressure gas; 0-30 inch W.C. range. Use low pressure type 2-1/2 inch dial pressure gauge with appropriate range, OCI Model CO 34, Trerice, Weksler or approved equal.

PART 3 - EXECUTION

3.1 GENERAL:

A. Route gas service entrance piping into building to avoid interference and damage.

B. Provide manual shutoff valve, gas cock and gauge, ![seismic valve,] ![fire safety shutoff valve].

C. Emergency gas shut off valves shall be installed outside the building. Valves shall be labeled.

3.2 UNDERGROUND PIPING:

A. Underground piping shall be:

1. Carbon steel - A53/A106-welded.

B. Underground steel piping shall have at least 18 inch of proper backfill cover.

C. Underground piping shall be protected from corrosion. Provide coated piping and fittings. Repair damaged coating at welds.

D. Install sacrificial anodes on steel piping intervals not exceeding 100 ft.

E. Gas lines routed under a building shall be steel and shall be encased in a sch 40 outer conduit (at least 3 pipe sizes larger than the gas line).

1. Conduit shall be seal welded to the gas pipe inside the building.

2. Conduit shall be vented to outdoors.

3. See paragraph D above for sealing conduit through wall penetration.

4. Conduit shall be protected from corrosion. See paragraph B above.

3.3 GAS SERVICE:

A. Coordinate installation of gas service line with local gas company. Pay all fees.

B. Provide 12 inch elevated meter mounting pads on top of a 4 inch thick concrete pad for support of gas meter and piping.

C. Provide (two) 8 inch diameter pipe bollards for gas meter protection.

D. Bollards shall be six feet long (3 feet below grade), mounted in a 24 inch diameter hole, filled with 3,000 psi concrete.

3.4 INTERIOR PIPING:

A. Connect to entering line and distribute gas to equipment items requiring gas and as indicated. Perform work in accord with applicable A.G.A., N.F.P.A. 54, State and Local codes. Install gas stop valves and drip legs at each equipment item. Piping shall be adequately drained with a minimum slope of 1/4 inch per 15 feet and drip legs (full size of pipe) installed at additional points where condensate may collect. Install pressure reducing valves as required to provide pressure within equipment manufacturer's requirements.

3.5 EXTERIOR PIPING:

A. Exterior piping shall be schedule 40 carbon steel.

B. Piping 2 inch and smaller may use threaded fittings. Piping 2 ½ inch and larger shall use welded fittings and flanged valves.

C. Exterior piping shall be coated with an alkyd enamel primer (minimum dry thickness 3 mils).

D. Exterior piping shall be supported on galvanized B-line channels and pipe clamps.

3.6 CONNECTING:

A. Connect equipment items furnished under other sections of specifications.

3.7 VENT PIPING FROM REGULATORS:

A. Extend separate full size vent pipes from each regulator outside. Terminate each vent separately with a screened opening.

3.8 TESTS:

A. Test system in accordance with A.G.A., International Fuel Gas Code, N.F.P.A. 54, and applicable State and Local codes.

3.9 ACCESS PANELS:

A. Provide access panels for valves and other items requiring maintenance in enclosed spaces. See Section 15050 for access panel specification. Avoid installing gas appurtenances in enclosed spaces where possible. Install in enclosed spaces only as allowed by applicable codes.

END OF SECTION 23 20 10

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SECTION 23 31 13 - LOW PRESSURE DUCTWORK

PART 1 - GENERAL

1.1 SCOPE OF WORK:

A. The work required under this section includes all work necessary for a complete installation of ductwork and accessories.

1.2 CODES AND STANDARDS:

A. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

1. HVAC Duct Construction Standards: Metal and Flexible

2. HVAC Air Duct Leakage Test Manual

B. National Fire Protection Association (NFPA):

1. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems

2. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning System

3. 101 - Life Safety Code

C. American Society of Heating, Refrigerating and Air Conditioning Engineering (ASHRAE):

1. Fundamentals Handbook

2. Equipment Handbook

1.3 SUBMITTALS:

A. Submittals (for each duct system) shall include the following:

1. Sheet Metal:

a. Gages by sizes
b. ASTM Standards

2. Duct Fabrication Standards and Reinforcement:

a. Joint construction
b. Fitting construction
c. Joint and reinforcement spacing
d. Splitter damper and duct tap details
e. Flange details

3. Hangers:

   a. Rods - sizes by duct
   b. Straps
   c. Trapeze
   d. Spacing

4. Duct sealers

5. Flexible connectors

6. Flexible ductwork

7. Manual Dampers

8. Control Dampers

9. Actuators

B. Submittals shall include testing or listing certification, dimensional data and manufacturers literature on all manufactured products.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Ductwork shall be fabricated from sheet metal products conforming to the following material standards:

1. Galvanized Steel - ASTM A653 (G60)

2. Aluminum - ASTM B209

3. Stainless Steel - ASTM A480

B. Duct system shall be fabricated with sheet metal thicknesses and reinforced in accordance with SMACNA as shown on the drawings and as described herein.

C. Unless noted otherwise the minimum pressure/velocity classification shall be 2 inch W.G. plus or minus, at 2500 ft. per minute, duct seal class "A".

D. Ducts 18 inches and larger on any side shall be stiffened by beading on not to exceed 12 inch centers.

E. All longitudinal seams shall be grooved, double or Pittsburgh type (except on watertight ducts or on heavy gauge ducts).

F. Branch connections in supply ducts shall be fabricated per the following schedule:

Maximum Branch Size	Branch Connection

Up to, Rectangular equivalent to 12 inch round	45 deg. tap collar with volume damper in branch
All other duct branches	Proportioned duct, with adjustable splitter damper

G. Branch connections in return or exhaust ductwork shall be made with 45 degree entry fittings. If ducts are the same depth use parallel branch connection.

H. Where acoustical or thermal insulation is applied on the inside of ductwork, size of ductwork shall be increased so that the duct size shown on the drawings are the dimensions of the inside of the insulation.

2.2 GALVANIZED STEEL DUCTWORK:

A. All junctions, bends, turns or elbows in all ducts or risers shall have a large radius (centerline radius equal to 1-½ times duct width) in the throat in order to minimize the frictional resistance.

B. Vanes shall be provided in elbows with 90 degree throats and throat radii less than 1-½ times duct width, and shall be located in accordance with ASHRAE standards. Double-vane airfoil-type turning vanes shall be provided for all square turns.

C. Replacement ductwork for office areas shall be galvanized steel. Refer to plans for duct materials in other facility areas.

2.3 ALUMINUM DUCTWORK:

A. Ducts shall be fabricated from .050 inch thick aluminum and shall be reinforced at joints and at intermediate points not exceeding 2 ft. 0 inch. Intermediate reinforcement shall be aluminum flat stock welded to duct. Joint reinforcement shall be welded companion flanges. All reinforcements shall be aluminum. Refer to SMACNA.

B. Exposed ductwork shall have stainless steel hangers.

C. All duct surfaces that contact uncoated steel or copper shall be di-electrically isolated with two coats of zinc chromate paint, one layer of asphalt impregnated paper, or one coat of bituminous paint.

2.4 STAINLESS STEEL DUCTWORK:

A. All exposed ductwork and supports in finished areas shall be constructed of stainless steel including companion angle flanges.

2.5 HANGERS AND SUPPORTS:

A. Building Attachments: Concrete inserts or structural steel fasteners appropriate for building materials.

B. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.

1. Hangers installed in non-conditioned spaces and outdoors: Electrogalvanized, all-thread rod or galvanized rods with threads painted after installation.

2. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.

C. Hanger Materials: Stainless, sheet steel or round, threaded stainless steel rod.

1. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.

D. Duct Attachments: Sheet metal screws, blind rivets or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports: Steel shapes complying with ASTM A36.

1. Supports for Stainless-Steel Ducts: Stainless-steel support materials.

2. Supports for Aluminum Ducts: Aluminum support materials, unless materials are electrolytically separated from ductwork.

2.6 SEALANT MATERIAL:

A. Duct Sealer: Solvent or water based type U.L. classified meeting NFPA 90A Class 1 with zero fire and smoke development rating. Sealer shall be United Sheet Metal, United Duct Sealer, or Hardcast Iron Grip No. 601.

2.7 FLEXIBLE CONNECTORS:

A. Flexible connectors shall be U.L. listed, neoprene coated heavy glass fabric. Fabric shall be Ventglas, manufactured by Ventfabrics, Inc.

2.8 FLEXIBLE DUCTWORK:

A. Flexible duct shall be UL listed and labeled as Class 1, Air Duct Connector, in accordance with U.L. Standard 181 and shall meet the requirements of the latest NFPA Bulletin, No. 90A and No. 90B for flame spread and smoke development rating.

B. Flexible duct shall be rated for a maximum pressure of 6 inch positive and 5 inch negative and 5500 fpm maximum velocity. Air duct shall consist of: CPE liner, coated spring steel wire helix, fiberglass insulating blanket, fiberglass scrim and reinforced aluminum vapor barrier. Insulation valve shall be a minimum or R-6. Edges of liner shall be protected by sheet-metal noisings.

C. Duct shall be Flexmaster Type 8M or prior approved equal.

2.9 MANUAL DAMPERS:

A. Single Blade Dampers:

1. Single Blade Dampers shall be constructed of 22 gauge galvanized steel (blade and frame). Single blade dampers shall be limited to a 12 inch high blade. Blade edges shall be crimped or reinforced. Damper levers shall indicate positively the open and closed position. End bearings shall be molded synthetic. Dampers shall be Ruskin MD25 or approved equal (Ruskin MDRS25 for round ducts).

B. Multiblade Dampers:

1. Multiblade dampers shall be constructed of sheet metal the same material as the adjacent ductwork. Damper frame shall be not less than 16 ga., damper blades not wider than 6 inches crimped or reinforced. Damper levers shall indicate positively the open and closed position. End bearings shall be molded synthetic. Damper shall be Ruskin MD35 or approved equal.

C. Manual dampers shall be Ruskin, Greenheck, Air Balance or prior approved equal.

2.10 AUTOMATIC CONTROL DAMPERS:

A. All control dampers shall be standard products of damper or temperature control manufacturers unless noted otherwise. Local fabrication of dampers is not allowed.

B. Dampers and seals suitable for temperature ranges of -40 to 200 degrees F. Dampers shall be opposed blade type, and the Contractor shall submit construction data for all control dampers with the temperature control submittal. Damper shall be leakage Class 1A.

C. Dampers shall be Ruskin Model CD50. Greenheck and Air Balance are approved equals.

2.11 ELECTRIC ACTUATORS:

A. Actuators shall be spring return type, which returns actuator shaft to its full normal mechanical travel upon power failure. Damper motor drive mechanism will include holding brake to keep the return spring from drawing the actuator from driving toward its normal position unless power is interrupted. Housing shall be die-cast aluminum.

B. Actuators shall be provided with mounting brackets, shaft linkage assemblies, and end switches as required by sequence of operations.

C. Actuators shall include the following features:

1. Two position (on/off) control or modulating as required by sequence of operations.

2. Torque: 44 in lb.

3. Voltage: 120 volts AC.

4. Operating Speed: 45 seconds for 2-position.

D. Two position actuators shall be Honeywell MS8105 series or approved equal.

PART 3 - INSTALLATION

3.1 GENERAL:

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction - Metal and Flexible," unless noted otherwise.

B. Ductwork hangers shall be supported from fasteners attached to structure.

C. Provide angles (same material as duct) at points where duct penetrates walls, to close off space between wall opening and duct.

D. Duct material and pressure classes have been identified on the drawings. Any duct shown on the drawing but not identified shall be low pressure galvanized steel. (2 inch W.G. 2500 fpm).

3.2 INDOOR DUCTWORK:

A. Suspend horizontal ducts on not to exceed 6 ft. spacing by galvanized steel straps 1 inch x no. 16 ga. for sizes up to 60 inch width, 1-1/2 inch x no. 16 ga. for sizes up to 96 inch width, and 2 x 2 x 1/4 inch trapeze shelf angles for ducts wider than 96 inches. Unless noted otherwise straps shall be fastened to sides of ducts with not less than two sheet metal screws. Bottom ends of straps shall hook 2 inches under ducts and be secured with a sheet metal screw through bottom of ducts (except watertight ducts).

B. Vertical ducts shall be supported at each floor by steel angles attached to the long sides of the duct. Angles shall rest on floor or steel framework and be secured to duct with sheet metal screws.

C. Support angles shall be sized according to duct size:

Duct Size	Riser Support Size
Up to 36"	1-¼ x 1-¼ x ¼
Up to 48"	1-½ x 1-½ x ¼
Up to 60"	2-½ x 2-½ x ¼
Up to 72"	3 x 3 x 5/16
Up to 84"	3 x 3 x 5/16
Up to 96"	4 x 4 x ¼

3.3 OUTDOOR DUCTWORK:

A. Provide supports from roof or wall brackets for ductwork mounted outdoors.

B. Slope ductwork to prevent water accumulating on ducts. Duct slope shall be a minimum of 1:24.

C. Duct shall be supported on mill galvanized steel angle brackets, bolted, flashed and counter flashed to roof.

D. Vertical ducts shall be supported on welded angle bracket supports anchored to wall. Brackets shall be hot dip galvanized after fabrication.

3.4 DUCT SEALER:

A. All ductwork shall be as airtight as possible. Transverse seams shall be taped and sealed with two layers of United Sheet Metal, Uni-Cast or caulked with duct sealer.

3.5 FLEXIBLE CONNECTORS:

A. Install flexible connectors at all supply and exhaust fans and other air handling units with inlet and outlet duct or casing connections.

B. Connectors shall be suitable for the pressure of the units involved and shall be sealed airtight.

C. Connectors shall be not less than 4 inches long (in clear) and properly attached to duct and fan connection collar by 1 x 1/8 inch draw band (fabricated of the same material as adjacent ductwork) firmly clamped around collars in such a manner as to be airtight and secured to collars with sheet metal screws. Connectors shall not be painted.

D. Connectors shall not be used as transition pieces between fan and ductwork.

3.6 FLEXIBLE DUCTWORK:

A. Flexible ducts shall be used for straight runs of duct or offsets up to 45 degrees, but not exceeding 48 inches in length. The use of flexible ducts as elbows with more than a 45 degree bend will not be permitted.

B. Flexible ductwork shall be secured to rigid ductwork and unit openings by sliding the flexible duct over the rigid duct, sealing with an approved adhesive, clamping with a suitable clamp and taping.

3.7 MANUAL DAMPERS:

A. Install dampers where shown or called for on the drawing. Install damper operating hardware.

3.8 LOUVERS:

A. Make connections to louvers. Where duct size is less than full louver opening, close off remaining unused louver opening with an insulated panel assembly consisting of 24 ga stainless sheet metal screwed to the louver, 2 in. thick 3 PCF

fiberglass rigid board and covered with a 22 ga stainless sheet metal outer skin. Seal all openings.

3.9 ELECTRIC ACTUATORS:

A. Provide electric motor operators for all control dampers as required by the sequence of operations.

3.10 AUTOMATIC DAMPERS:

A. Install all motor operated control dampers in louver plenums.

END OF SECTION 23 31 13

SECTION 23 34 23 - POWER VENTILATORS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This specification describes the requirements for labor and materials necessary for the installation of power ventilators included as part of the building mechanical system.

1.2 SUBMITTALS:

A. Submit catalogue literature pertaining to the power ventilator listed within his Section to Architect/Engineer for approval.

B. Submittals shall include the following:

1. Dimensional information

2. Electrical connection and motor data

3. List of accessories or auxiliary items

4. Sound power levels at the mid frequency of each band.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Power ventilators which are scheduled or referred to by model number or catalogue number are intended to include all materials covered by such number. Any required accessories for the installation of the fan are to be by the same manufacturer unless otherwise noted.

B. All wiring and electrical components shall comply with the National Electric Codes (NEC). All materials shall be U.L. Listed.

C. Fans shall be listed by Underwriters Laboratories (UL 705).

D. Fans shall bear the AMCA certified ratings seal for sound and air performance.

E. Fan wheels shall be balanced in accordance with AMCA Standard 204, *Balance Quality and Vibration Levels for Fans*.

F. Fan assembly shall bear an engraved aluminum nameplate.

2.2 WALL MOUNTED PROPELLER EXHAUST FANS - BELT DRIVE

A. Fan shall be a wall mounted, belt driven steel propeller exhaust fan.

B. The fan shall be of bolted and welded construction utilizing corrosion resistant

fasteners. The motor, bearings and drives shall be mounted on a tubular steel power assembly. The power assembly shall be bolted to a minimum 14 gauge wall panel with continuously welded corners and an integral venturi.

C. All steel fan components shall be phenolic epoxy coated. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

D. Propeller shall be a high-efficiency fabricated steel design with blades securely fastened to a minimum 7 gauge hub. The hub shall be keyed and locked to the fan shaft utilizing two setscrews.

E. Motor shall be NEMA Design B with Class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.

F. Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

G. Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

H. Provide with accessories noted on schedules. Provide phenolic epoxy coating for steel construction accessories.

I. Fan shall be the XMWH as manufactured by Loren Cook Company. Greenheck, Acme and Penn Ventilator are approved equal.

2.3 WALL MOUNTED PROPELLER SUPPLY FANS - BELT DRIVE

A. Fan shall be a wall mounted, belt driven steel propeller supply fan.

B. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The motor, bearings and drives shall be mounted on a tubular steel power assembly. The power assembly shall be bolted to a minimum 14 gauge wall panel with continuously welded corners and an integral venturi.

C. All steel fan components shall be phenolic epoxy coated. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

D. Propeller shall be a high-efficiency fabricated steel design with blades securely fastened to a minimum 7 gauge hub. The hub shall be keyed and locked to the fan shaft utilizing two setscrews.

E. Motor shall be NEMA Design B with Class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.

F. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron

pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

G. Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

H. Provide with accessories noted on schedules. Provide phenolic epoxy coating for steel construction accessories mounted indoors.

I. Fan shall be the XLWH as manufactured by Loren Cook Company. Greenheck, Acme and Penn Ventilator are approved equal.

2.4 WALL MOUNTED PROPELLER EXHAUST FAN - DIRECT DRIVE

A. Fan shall be a wall mounted, direct driven, aluminum propeller exhaust fan with integral housing, shutter and inlet guard.

B. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The motor shall be mounted on a 12 gauge steel wire guard. The wire guard shall be bolted to a minimum 14 gauge wall panel with continuously welded corners and an integral venturi. Fan shall be enclosed in minimum 18 gauge galvanized steel wall housing with factory installed shutter and inlet guard.

C. All steel fan components shall be phenolic epoxy coated. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

D. Propeller shall have aluminum blades riveted to a painted steel hub. The hub shall be securely fastened to the motor shaft utilizing two setscrews.

E. Motor shall be NEMA Design B with Class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.

F. Provide with accessories noted on schedules. Provide phenolic epoxy coating for steel construction accessories.

G. Fan shall be the XPD as manufactured by Loren Cook Company. Greenheck, Acme and Penn Ventilator are approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install fan in accordance with manufacturer’s installation instructions.

B. Install fans with clearances for service and maintenance.

END OF SECTION 23 34 23

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SECTION 23 81 26 - SPLIT SYSTEM DX AIR HANDLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. The work required under this sections includes all work necessary for a complete installation of split system DX air handling units.

1.2 COORDINATION:

A. The air handling units of one manufacturer have been used as the basis of design. Any modifications to ductwork, piping, wiring, or building structure, that results from the use of any other units shall be coordinated with all trades prior to delivery of approved equipment from the manufacturer. Any modifications required shall be performed without incurring any additional cost to the Contract.

1.3 CODES AND STANDARDS:

A.	NFPA 90A	Installation of Air conditioning and Ventilation Systems.
B.	ANSI/AFBMA 9	Load Ratings and Fatigue Life for Ball Bearings.
C.	SMACNA	HVAC Duct Construction Standards.
D.	ARI 410	Standard for Forced Circulation Air-cooling and Air-Heating Coils.
E.	ANSI/UL 900	Test Performance of Air Filter Units.
F.	AMCA 301	Method for Publishing Sound Ratings for Air Moving Devices.
G.	NFPA 70	National Electrical Code
H.	UL 1995	Heating and Cooling Equipment

1.4 SUBMITTALS:

A. Submittals shall include the following:

1. Unit Housing

   a. Certified dimensional drawings
   b. Casing Construction
   c. Insulation

2. Fan

   a. Fan curves
   b. RPM
   c. Brake horsepower

3. Motor

a. Manufacturers data sheet

4. Coils

a. Manufacturers data sheet
b. Coil selection input/output using an ARI-410 certified selection program

5. Filter

a. Manufacturers data sheet
b. Filter frame size and quantity of filters

6. Sound Power Level

a. Octave band reference 10^{-12} watt
b. Inlet and outlet

1.5 ACCEPTABLE MANUFACTURERS:

A. Carrier Model 40RM is basis of design. Trane and AAON are approved equals.

PART 2 - PRODUCTS:

A. General:

1. Air handling units shall be completely factory assembled including coil, condensate drain pan, fan motor(s), filters and controls in an insulated casing that can be applied in either vertical or horizontal configuration.

2. Units shall be rated and tested in accordance with ARI standard 210, 360, and 270 (Cooling only). Units shall be UL listed and labeled in accordance with UL 465 and UL 1995 for indoor blower coil units.

B. Casing:

1. Unit casing shall be constructed of zinc coated, minimum 20 gauge, G-90 galvanized steel. Casing shall be completely insulated with fire-retardant, permanent, odorless glass fiber material with R-valve not less than 4. Knockouts shall be provided for unit electric power and refrigerant piping connections.

C. Direct Expansion Coil:

1. Coils shall consist of copper tubes with aluminum fins bonded to the tubes by mechanical expansion. Coil tubing shall be internally rifled to maximize heat transfer. Suction and liquid line connections or supply and discharge connections shall be made on the same side of the coil.

2. Direct-expansion coils shall include factory-installed thermostatic expansion valves (TXVs) for refrigerant control. The TXVs shall be capable of external adjustment.

3. Coils shall be leak tested at a pressure of not less than 375 psig.

D. Electric Heaters:

1. Provide unit mounted electric heaters as scheduled.

2. Electric heat assembly shall be UL, ETL, and CSA approved for direct installation on fan discharge.

3. Heater assembly shall have single-point power wiring and include contactors with 24 volt coils, power wiring, 24 volt control wiring terminal blocks, and a hinged access panel.

4. Electric heater elements shall be constructed of heavy-duty nickel chromium elements.

E. Condensate Drain Pans:

1. Drain pans shall be one-piece, corrosion resistant, and fully drainable.

2. Coil shall be mounted above, not in, the drain pan to allow full inspection or cleaning of drain pan.

3. Unit shall contain condensate drain pans for both horizontal and vertical applications. Drain pans shall have connections on both sides of the unit.

F. Fan:

1. Double inlet, double width, forward curved, centrifugal-type fan(s) with adjustable belt drive shall be standard. Thermal overload protection shall be standard on motor. Fan and motor bearings shall be permanently lubricated.

G. Controls:

1. Magnetic motor starter, low voltage terminal strip, and single point power entry shall be included. All necessary controls shall be factory-insulated and wired.

2. Evaporator defrost control shall be included to prevent compressor slugging by temporarily interrupting compressor operation when low evaporator coil temperatures are encountered.

H. Filter:

1. Filters shall be one inch. Filters shall be accessible from either side through the coil access panel.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of refrigerant and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. Install units in accordance with manufacturer's written instructions.

B. Install floor mounted units on concrete housekeeping pads.

C. Arrange installation of units to provide access space around air handling units for service and maintenance.

D. Install piping adjacent to machine to allow service and maintenance.

E. Connect condensate piping to drain pans. Extend to nearest floor drain. Drain line shall be installed with a slope of not less than 1/8 inch per foot down in the direction of flow.

F. Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection. Refer to details shown on drawings.

G. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.

H. Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls.

I. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.

J. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

K. Clean air handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face. Comb coil fins as required.

L. After completing system installation and testing, adjusting, and balancing air handling and air-distribution systems, clean filter housings and install new filters.

END OF SECTION 23 81 26

SECTION 23 81 36 - DUCTLESS SPLIT SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. The work required under this sections includes all work necessary for a complete installation of ductless split systems.

1.2 CODES AND STANDARDS:

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be rated in accordance with Air-conditioning Refrigeration Institute's (ARI) Standard 210 and bear the ARI Certification label.

1.3 SUBMITTALS:

A. Submittals shall include complete data on the following:

1. Condensing Unit

a. Capacity
b. Dimensional Information
c. Electrical Requirements

2. Evaporator Section

a. Capacity
b. Filter
c. Sound power level for each octave band

1.4 DELIVERY, STORAGE AND HANDLING:

A. Unit shall be stored and handled according to the manufacturer's recommendations.

B. The wireless controller shall be shipped inside the carton with the indoor unit and able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.5 WARRANTY:

A. The units shall have a manufacturer's parts and defects warranty for a period one (1) year from date of installation. The compressor shall have a warranty of 6 years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

PART 2 - PRODUCTS:

2.1 GENERAL:

A. The cooling or heat pump systems shall be a ductless split system with Variable Speed Inverter Compressor technology. The system shall consist of an indoor section with wired, wall mounted controller and a horizontal discharge outdoor unit. System efficiency shall meet or exceed 13.0 SEER.

2.2 WALL MOUNTED INDOOR UNIT:

A. Cabinet:

1. The indoor unit cabinet shall be wall mounted by means of a factory supplied mounting plate, The cabinet shall be formed from high strength molded plastic with front panel access for filter.

2. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor.

3. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

B. Fan: The evaporator fan shall be high performance, double inlet, forward curve, direct drive sirocco type. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall have multiple speeds.

C. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower noise levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.

D. Filter: Return air shall be filtered by means of an easily removable washable filter.

E. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

F. Electrical: The electrical power of the unit shall be as scheduled. The power to the indoor unit shall be supplied from the outdoor unit. A three (3) conductor AWG-14 wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.

G. Control:

1. The control system shall consist of two (2) microprocessors, one on each

indoor and outdoor unit. Field wiring shall run directly from the indoor unit interconnected by a single non-polar two-wire AWG-16 stranded cable to the wall mounted controller with no splices.

2. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

3. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.

4. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F). Temperature changes shall be by increments of 1°F with a range of 67°F to 87°F.

5. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.

6. The control voltage from the wired controller to the indoor unit shall be 12 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.

7. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

2.3 CEILING MOUNTED INDOOR UNIT - RECESSED:

A. Cabinet:

1. The indoor unit cabinet shall be a space-saving ceiling-recessed cassette type. The cabinet shall be formed from galvanized sheet metal coated with high-density foam insulation.

2. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, drain left mechanism, control circuit board, fan, and fan motor. Single branch ducting

shall be allowed from cabinet. The cabinet panel shall have provisions for a field installed filtered outside air intake.

3. A separate grill assembly shall be attached to the front of the cabinet to provide supply air vanes in four directions and a center mounted return air section. The four-way grill shall be fixed to bottom of cabinet allowing two, three or four-way blow. The grill vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space.

4. The unit, in conjunction with the wired, wall-mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and integral refrigerant pipes shall be purged with dry nitrogen and caped before shipment from the factory.

B. Fan:

1. The indoor fan shall be an assembly with a turbo fan propeller, direct driven by a single motor and shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.

2. The indoor fan shall consist of multiple speed settings and Auto mode. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.

C. Vane:

1. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow with switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.

2. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.

3. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space.

4. Filter: Return air shall be filtered by means of an easily removable, long life, washable filter.

D. Coil:

1. The indoor unit coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange.

2. The heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory.

3. A condensate pan with drain connections shall be provided under the coil. The unit shall also include a built-in, automatic condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan. The lift mechanism shall be equipped with a positive acting liquid level sensor to shut down the indoor unit if liquid level in the drain pan reached maximum level.

4. Both refrigerant lines between the indoor unit and outdoor unit shall be fully insulated.

E. Electrical: The electrical power of the unit shall be as scheduled. The indoor unit shall be provided with a system allowing the indoor unit to be powered and controlled directly from the outdoor unit using a 14 gauge (AWG) 3-wire connection plus ground providing both primary power and integrated, by-directional, digital control signal without additional connections.

F. Control:

1. The control system shall consist of two (2) interconnected microprocessors, one in each indoor and outdoor unit. A three (3) conductor 14 ga. AWG wire with ground method shall provide power feed and bi-directional digital control transmission between the outdoor and indoor units.

2. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller display panel.

3. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and for controlling the operation of the outdoor unit.

4. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large liquid crystal display (LCD).

5. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat / Auto / Cool / Dry / Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F with a range of 67°F to 87°F.

6. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.

7. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. Temperature sensing shall be done by a Thermistor mounted in the return air stream of the indoor unit. An alternate temperature sensor shall be located within the wall controller. Selection of the sensor is by switch in the indoor unit.

8. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,650 feet.

9. The control voltage from the wired controller to the indoor unit shall be a digital +/-24 volts, DC signal. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.

10. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

11. A two wire (one pair) twisted, stranded, 18 gauge (AWG), jacketed, control cable shall be used to connect the controller to the indoor unit.

2.4 OUTDOOR UNIT:

A. General:

1. The connected indoor unit must be of the same capacity as the outdoor unit. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.

2. The outdoor unit shall be capable of operating at 0°F ambient temperature without additional low ambient controls. Provide wind baffle.

3. The outdoor unit shall be able to operate with a maximum height difference of 100 feet indoor unit to outdoor unit.

4. System shall have a maximum refrigerant tubing length of 100 feet between indoor and outdoor units without the need for line size changes, traps or additional oil.

5. Units shall be pre-charged for a maximum of 70 feet of refrigerant tubing. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.

B. Cabinet: The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a munsell 3Y 7.8/1.1 finish. The fan grille shall be of ABS plastic.

C. Fan: The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have

horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.

D. Coil: The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.

E. Compressor: The compressor shall be a DC rotary compressor with Variable Compressor Speed Inverter Technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

F. Electrical: The electrical power of the unit shall be as scheduled. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

PART 3 - EXECUTION

3.1 GENERAL:

A. Install unit in accordance with manufacturers instructions.

B. Install full size condensate drain piping from unit to location shown on plan. Drain line shall be installed with a slope of not less than 1/8 inch per foot down in the direction of flow.Install condensing units according to manufacturers written instructions.

C. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer’s recommended clearances.

D. Install ground-mounted units on concrete housekeeping pad 4 inches larger than condensing unit on each side.

E. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Provide refrigerant accessories shown on the drawings.

F. Route control wiring in conduit.

3.2 TESTING:

A. After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks and replace lost refrigerant oil. Use electronic leak detector to test for

leakage.

B. After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements. Record suction pressure.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units with new units and retest.

3.3 MISCELLANEOUS:

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Clean units to remove dirt and construction debris and repair damaged finishes.

B. Insulate suction piping. Paint insulation.

3.4 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain ductless split systems. Session shall be a minimum of four hours.

END OF SECTION 23 81 36

DIVISION 26/27/28
ELECTRICAL

12/7/2022

KREBS 20518

SECTION 26 05 00 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1. DESCRIPTION

A. General Conditions:
   1. The accompanying General Conditions (front-end specifications) shall apply to and form a part of this section.

B. General Requirements:
   1. Carefully examine General Conditions, other specification sections, and other drawings (in addition to Electrical) in order to be fully acquainted with their effect on electrical work.
   2. Do all work in compliance with all applicable codes, laws, and ordinances, the National Electrical Safety Code, the National Electrical Code (hereinafter referred to as “Code”), applicable energy codes, and the regulations of the local utility companies. Obtain and pay for any and all required permits, inspections, certificates of inspections and approval, and the like.
   3. Cooperate with other trades and contractors at job. Perform work in such manner and at such times as not to delay work of other trades. Complete all work as soon as the structure and installations of equipment will permit. Patch, in a satisfactory manner and by the proper craft, any work damaged by electrical workmen.
   4. The Owner shall be provided access to all software to include copies of software for all systems provided under this division of the specifications. Software shall be password protected where applicable.
   5. Only qualified electrical sub-contractors will be allowed to submit proposals for this project. In order to be considered qualified, contractor shall have completed a minimum of five (5) projects of similar type/scope and equal or greater magnitude and complexity within the last ten (10) years. Sub-contractors without qualifications will be rejected. If desired, potential electrical sub-contractors may submit qualification evidence for review and pre-bid approval a minimum of ten (10) days prior to bid. Previous projects used to meet this experience requirement must have included similar (or greater) scopes of work for each of the following areas:
      a. Power Systems.
      b. Control Systems.
      c. Instrumentation Systems.
   6. Electrical contracting firm shall be licensed as an electrical contractor in the state where work will be performed

1.2. GENERAL SCOPE OF ELECTRICAL WORK (REFER TO DRAWINGS FOR OTHER SPECIFIC SCOPE ITEMS)

A. Furnish all labor and materials to complete electrical work as shown on drawings and/or herein specified.
B. Remove all existing electrical equipment and wiring made obsolete by this project and remove or relocate all electrical services located on or crossing through the project property, either above or below grade, which would obstruct the construction of the

project or conflict in any manner with the completed project or any code pertaining thereto. Dispose of salvageable materials as directed by the Engineer. Contractor shall schedule meeting to review scope of electrical demolition and to confirm scope and phasing of proposed demolition with the owner in the presence of the prime consultant prior to start of any electrical demolition.

C. Furnish and install complete power, telephone and other electrical services as shown on drawings and/or specified herein.
D. Pay all electrical utility company service charges (if any) in connection therewith, including permanent meter deposit. Meter deposits will be refunded to Contractor at time of Owner's acceptance.
E. Furnish and install complete power distribution system as shown on drawings and/or specified herein.
F. Furnish and install a complete Power Generation and Automatic Transfer Switch and Paralleling Switchgear System as shown on drawings and/or specified herein.
G. Furnish and install complete variable frequency drives and associated devices for motors as shown on drawings and/or specified herein.
H. Furnish and install disconnect switches for motors as shown on drawings and/or specified herein.
I. Furnish and install complete electrical grounding systems as shown on drawings and/or specified herein.
J. Install and connect electrical equipment mentioned in Division 26/27/28 Specifications or noted in drawings, whether furnished by electrical contractor or by others.
    1. Where shown or specified, equipment furnished by others shall be installed and connected under this Contract.
    2. Where shown or specified, Contractor shall receive, unpack, check and assume custody of equipment furnished by Others. Contractor shall assume responsibility for care and safekeeping of this equipment, when delivered into his custody. He shall protect it from moisture, dust and damage during construction and until Owner acceptance of project.

K. Furnish and install complete electrical lighting systems as shown on drawings and/or specified herein.
L. Furnish and install all electrical items shown on drawings and/or herein specified, unless shown or specified otherwise.
M. Furnish and install complete controls, instrumentation & auxiliary systems as shown on drawings and/or specified herein.
N. Furnish and install a complete Surge Protection System as shown on drawings and/or specified herein.
O. Furnish and install a complete Building Lightning Protection System as shown on drawings and/or specified herein.
P. Procure and pay for permits and certificates as required by local and state ordinances and fire underwriter's certificate of inspection.
Q. Balance loads as equally as practicable on services, distribution feeders, circuits and buses. Provide typewritten directory for each panel.
R. Unless specifically indicated or required otherwise, terminate all circuitry/cabling provided within this contract at associated equipment/devices/etc. in accordance with all applicable codes, standards and supplier requirements, whether associated equipment/device/etc. is furnished within this contract or by others.
S. Complete field testing, adjustment & startup of all systems listed above as shown on drawings and/or specified herein.

PART 2 - PRODUCTS

2.1. APPROVED MATERIALS AND DEVICES

A. Where not otherwise specified, provide only new, standard, first-grade materials/systems throughout, conforming to standards established by Underwriter's Laboratories, Inc., and so marked or labeled, together with manufacturer's brand or trademark. All equipment/systems subject to approval of Engineer before installation. All like items and associated equipment/systems shall be of one manufacturer.

B. To ensure proper coordination, it is intended that all electrical equipment and materials specified in Division 26/27/28 of these specifications and shown on the electrical drawings be furnished and installed by the electrical sub-contractor. It will not be permissible for any of these items to be furnished directly by the general contractor without the electrical contractor's coordination.

C. To ensure commonality of spare parts, it is required that the electrical contractor provide the same brand for all circuit breakers, starters, power equipment, etc. provided under the following divisions of these specifications:
   1. SECTION 26 05 73: POWER DISTRIBUTION SYSTEM ELECTRICAL STUDIES
   2. SECTION 26 22 00: DRY TYPE TRANSFORMERS
   3. SECTION 26 24 13: SWITCHBOARDS
   4. SECTION 26 24 16: POWER PANELBOARDS - CIRCUIT BREAKER TYPE
   5. SECTION 26 24 17: LIGHTING PANELBOARDS
   6. SECTION 26 24 19: MOTOR CONTROL CENTERS
   7. SECTION 26 28 16: SAFETY SWITCHES AND FUSES

2.2. SUBMITTALS

A. All submittals to the design team shall be accompanied by a letter summarizing all proposed deviations from specified products or pre-approved substitutions. The absence of such a letter shall be understood to indicate that the contractor intends to meet all contract requirements, regardless of cut-sheets/data-sheets provided within the submittal.

B. Submit to Engineer ten (10) days prior to bid date three (3) copies of any items and/or manufacturers which are proposed as substitutes for those specified.

C. Submit to Engineer promptly after award of Contract and prior to purchasing, the number of copies required by the contract. All drawings of a specific item or system shall be made in one submittal, and within thirty (30) days after award of Contract. Shop drawings of all power equipment shall contain exact details of device placement, phasing and numbering, in form of elevations, for each major piece of equipment. Shop drawings shall be submitted on the following:
   1. SECTION 26 05 36: CABLE TRAYS
   2. SECTION 26 05 73: POWER DISTRIBUTION SYSTEM ELECTRICAL STUDIES
   3. SECTION 26 22 00: DRY TYPE TRANSFORMERS
   4. SECTION 26 23 00: PARALLELING SWITCHGEAR
   5. SECTION 26 24 13: SWITCHBOARDS
   6. SECTION 26 24 16: POWER PANELBOARDS - CIRCUIT BREAKER TYPE
   7. SECTION 26 24 17: LIGHTING PANELBOARDS
   8. SECTION 26 24 19: MOTOR CONTROL CENTERS
   9. SECTION 26 28 16: SAFETY SWITCHES AND FUSES
   10. SECTION 26 29 00: MANUFACTURED CONTROL PANELS
   11. SECTION 26 29 23: VARIABLE FREQUENCY DRIVES
   12. SECTION 26 32 13: GENERATOR SETS
   13. SECTION 26 36 23: AUTOMATIC TRANSFER SWITCHES
   14. SECTION 26 41 00: LIGHTNING PROTECTION SYSTEM

15. SECTION 26 43 00: SURGE PROTECTIVE DEVICES
16. SECTION 26 44 00: ELECTRICAL HEAT TRACING SYSTEMS
17. SECTION 26 50 00: LIGHTING MATERIALS AND METHODS
18. SECTION 27 10 00: STRUCTURED CABLING SYSTEM
19. SECTION 27 60 00: SCADA SYSTEM
20. SECTION 27 60 05: SCADA INSTRUMENTATION
21. ALL POWER DISTRIBUTION EQUIPMENT (i.e. SWITCHBOARDS, PANELBOARDS, DRY TYPE TRANSFORMER, ETC.)
22. ALL ELECTRICAL AND TELECOMMUNICATION EQUIPMENT LAYOUTS - Submittals shall include ¼" = 1'-0" CAD drawings (hand drawn sketches will not be accepted) of each electrical room, IT room, electrical equipment stand, generator area, or any other similar area with electrical equipment. Drawings shall indicate all panelboards, transformers, switchboards, generators, equipment racks, control panels, HVAC equipment, etc. that are located in each electrical/IT area. Layouts shall show that each piece of electrical equipment has the clearances, working space and dedicated equipment space required by applicable codes. No conduits to equipment within these areas shall be installed until submittals have been provided and returned without exception by the design team.
23. ALL CONTROL ITEMS & SYSTEMS

D. The contractor shall fully review, comment upon and correct all shop drawings as required to assure compliance with contract documents prior to submittal to Engineer. The failure of the contractor to properly review and correct shop drawings prior to submittal will result in rejection of shop drawings by the engineer. Review by the Engineer will be for general conformance with contract documents. The contractor shall be fully responsible for correctness of all submitted dimensions, details, quantities and locations.
E. None of the above items shall be installed until shop drawings or catalog data have been reviewed by Engineer without rejection or required resubmittal. Any listed item not submitted, even if specified, shall be considered not acceptable and shall be removed if directed.
F. Any required resubmittal will be reviewed by the Engineer for conformance with previously issued comments only. The contractor shall be responsible for verifying that all items not specifically requiring resubmittal have not been altered from the previously reviewed submittal.
G. Material proposed for substitution shall be of the same quality, perform the same functions, conform to such physical dimensions and appearance as are required by the Engineer. All material proposed for substitution is subject to the approval of the Engineer and his authority for approval is final. No material proposed for substitution will be considered unless all submittal data complies with the drawings and specifications of Section 16 as to time of submission, number of copies of submittal, and detail requirements.
H. Samples of material shall be furnished where required by drawings or Division 26/27/28 Specification, or as requested by the Engineer on items proposed as substitutes.
I. Submit to Engineer a certificate of final inspection from local inspection department.

PART 3 - EXECUTION

3.1. SITE VISIT

A. The Contractor shall visit the site to determine existing dimensions and conditions

affecting electrical work. Failure to do so in no way relieves Contractor of his responsibility under Contract.

3.2. CLEARANCE WITH UTILITIES

A. It shall be the responsibility of this Contractor, prior to bid, to reaffirm with the utility companies involved, that the locations, arrangement (and with power company voltage, phase, and metering required) and connections to utility service are in accordance with their regulations and requirements. If their requirements are at variance with these drawings and specifications, the Contract price shall include any additional cost necessary to meet those requirements without extra cost to Owner after a contract is entered into.
B. On many projects the utility company may levy charges due to locations, size or type service involved. The Contractor shall be responsible for these charges (including permanent meter deposit), unless such charges are not available prior to bid and Contractor so documents as described below. The meter deposit will be refunded to the contractor at time of Owner's acceptance.
C. Should above cost not be available, prior to bid, Contractor must submit a letter signed by a responsible utility company person so stating with his bid and in turn must be submitted by Prime Contractor with his bid to Owner. The cost will then be deleted from the Contract and become responsibility of the Owner.
D. Arrange with utility companies for such services as shown or herein specified and installation of meter where shown. Furnish with shop drawings a signed document from utility companies describing the location and type of services to be furnished and any requirements they may have. This document shall be signed for each utility company by a person responsible for granting such service.

3.3. WORKMANSHIP

A. All work shall be in accordance with the latest editions of NFPA 70 (National Electrical Code), NFPA 101 (Life Safety Code), National Electric Safety Code, International Building Code, applicable NECA standards and the rules and regulations of State and Local Authorities Having Jurisdiction.
B. All work shall be executed in a workmanlike manner and shall present a neat and mechanical appearance upon completion.
C. All equipment, devices, etc. shall be installed in accordance with manufacturer's recommendations.
D. All items shall be installed straight and plumb in a workmanlike manner and care shall be exercised so that like items are mounted the same position, heights and general location.
E. Keep site clean of accumulation of cartons, trash and debris.

3.4. SAFETY

A. The contractor is solely responsible for all job safety. Engineer assumes no responsibility for job safety. Maximum consideration shall be given to job safety and only such methods as will reasonably insure the safety of all persons shall be employed. The codes and regulations of OSHA shall be given strict compliance as well as such other codes, laws, and regulations as may be applicable.

3.5. CONTRACT DOCUMENTS

A. Contract documents indicate diagrammatically, extent, general character and approximate location of work. Where work is indicated but minor details omitted, furnish and install it complete so as to perform its intended functions. For details and mechanical equipment, follow drawings provided by other disciplines (Architectural, Mechanical, Structural, Civil, etc.) and fit electrical work thereto.
B. Contract documents consist only of the hardcopy documents issued by the Prime Engineer. Electronic documents issued directly by the electrical engineer to the contractor and/or its sub-contractors/vendors are issued for convenience only (electronic documents are not formal contract documents).
C. If the contractor and/or one of its suppliers require a one-time transfer of electronic files of the current electrical construction documents to prepare shop drawings (or for another similar purpose), it shall:
    1. Sign a waiver prepared by the electrical engineer prior to the transmittal of these files.
    2. Agree to pay the electrical engineer a fee of $50.00 per drawing, up to a maximum of $400 per transfer, payable upon receipt of the files.
    3. To the fullest extent permitted by law, indemnify, hold harmless, and defend JRA from all claims, damages, losses and expenses, including attorneys' fees arising out of or resulting from the use of the CAD files.

D. Take finish dimensions at job in preference to scaled dimensions.
E. Except as above noted, make no changes in or deviations from work as shown or specified except on written order of Engineer.

3.6. UNDERGROUND UTILITY/EQUIPMENT COORDINATION

A. Prior to commencement of work, verify exact locations of all existing or proposed underground utilities and/or underground equipment and verify that proposed electrical installation does not conflict with these items. Notify Engineer immediately if any conflict is found.

3.7. EQUIPMENT STORAGE

A. Store all electrical equipment in dry, covered locations as directed by equipment manufacturers. Contractor shall be responsible for replacing or repairing improperly-storted equipment as directed by Engineer.

3.8. EXCAVATION, CUTTING AND PATCHING

A. Perform all cutting and excavating as necessary for installation of electrical systems, unless specifically covered under another section. After Engineer's observation, complete all excavation, filling and backfilling as directed under specifications for preparation of site and earthwork. Foundations for equipment shall be as specified under concrete section. Concrete pads shall be minimum of 6" thick; unless greater thickness required by equipment manufacturer. Obtain specific approval of Engineer before cutting into any structural members.
B. For all such work employ competent workmen, and finish up in neat and workmanlike manner, equal to quality and appearance to adjacent work.

3.9. PENETRATIONS

A. All penetrations in water tight barriers shall be made so that barrier rating is not

compromised. Furnish roof flashing for all equipment installed under Division 26/27/28 that penetrates through the roof. Appropriate flashing is specified under roofing and sheet metal section. Supply these flashings for installation under roofing and sheet metal section.

B. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly to maintain the fire/smoke rating of the associated membrane.

C. Where penetrations are required through structural elements, verify penetration locations and sizes with structural engineer. In no case shall the structural integrity be compromised without written approval from structural engineer.

3.10. INSTALLATION OF EQUIPMENT - GENERAL

A. Care shall be exercised in exact routing and location of all items so as not to obstruct access to equipment, personnel walkways, or expose it to potential mechanical damage.

B. Items shall be securely anchored and/or fastened. Provide proper support for all equipment, devices, conduits, boxes, panels, etc. as required by code and for a workmanlike installation. Provide guy wiring for wood poles where required to prevent leaning. All construction shall meet the seismic design requirements of the building code. Items (especially transformers, light fixtures, equipment racks, freestanding gear, etc.) installed in seismic zones C, D, E or F shall be supported and braced per applicable codes and standards.

C. All wall, pole or frame-mounted electrical equipment shall be mounted to metal unistrut (or similar) frames of same material as electrical equipment. For example, pole-mounted stainless steel disconnect switches shall be mounted to stainless steel unistrut frames.

D. All electrical equipment, furnished by Contractor or by others shall be covered and protected during construction.

E. All control cabinets, panels, motor control centers and other electrical cabinets and enclosures shall have all trash removed and be vacuumed clean. All foreign paint, etc., shall be removed from exterior and all scratches in finish touched up with same color and material as original. Any rusted areas shall be sanded, primed and repainted.

F. All relays, starters, push-button and other control devices shall be cleaned and if necessary, lubricated with CRC 2-26 to assure free operation.

3.11. MOTORS, STARTERS AND CONTROLS

A. Unless otherwise specified or shown, all motors will be furnished and installed under other sections of this specification.

B. Electrical Contractor shall install all starters and all electrical power wiring and connections to motors and starters.

C. Unless otherwise specified or shown, all control items for motors shall be furnished, installed and wired in conduit by the electrician.

3.12. CIRCUITS AND BRANCH CIRCUITS

A. Outlets shall be connected to branch circuits as indicated on drawings by circuit numbers. No more outlets than are indicated shall be connected to a circuit.

B. Branch circuit homeruns shall be installed as shown on drawings. Multiple homerun conduits shall not be combined by contractor into larger, single homerun conduits unless specific permission is granted by the Engineer.

3.13. LUG/TERMINAL RATINGS

A. All lug/terminal ratings, sizes, locations, types, etc. shall be coordinated with the associated conductor sizes, types, routings, etc. by the contractor.
B. All lugs/terminals/etc. shall be rated for 75 degree C terminations (minimum, unless specified otherwise).

3.14. EQUIPMENT FAULT CURRENT RATINGS

A. All equipment and breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated distribution equipment. All interrupting ratings shall be full ratings. Where new devices or breakers are added to existing distribution equipment, the new devices/breakers shall have interrupting ratings matching or exceeding that of the existing distribution equipment.

3.15. OUTLET LOCATION

A. Symbols shown on drawings and mounting heights indicated on drawings and in specifications are approximate only. The exact locations and mounting height must be determined on the job and it shall be the Contractor's responsibility to coordinate with other trades to insure correct installation.

3.16. IDENTIFICATION

A. Each panel shall have each circuit identified. Panels without branch circuit nameplates shall have typewritten directories.
B. Each individually mounted switch, circuit breaker, starter and/or any other control or protective device shall identify equipment fed and fuse size, if any, by engraved plastic nameplate, white with black letters, screw attached.
C. See Specification Section 26 05 53 for additional requirements.

3.17. GROUNDING

A. All equipment shall be grounded and bonded in accordance with all state/local regulations, The National Electrical Code and as specified herein.

3.18. PAINTING

A. Refer to Painting/Finishing specifications for requirements regarding field painting of exposed conduit. Any scratches, dents or rust spots in conduit electrical enclosures, panels, motor control or any other electrical items shall have the dents removed, and they, along with any rust spots or scratches, sanded and touched up with the same exact color paint as original finish.

3.19. ACCEPTANCE TESTING

A. Upon completion of work, the entire electrical system installed within this project shall be tested and shall be shown to be in perfect working condition, in accordance with the intent of the specifications and drawings. It shall be the responsibility of the Electrical Contractor to have all systems ready for operation and to have an electrician available to operate same in accordance with and under the supervision of the observation representative(s) of the Engineer. The Electrician shall be available to assist in

removal of panel fronts, etc., to permit inspection as required.

B. The electrical sub-contractor shall include in bid price start-up assistance and training from a certified representative of the manufacturer for the following systems:
   1. SECTION 26 23 00: PARALLELING SWITCHGEAR
   2. SECTION 26 29 23: VARIABLE FREQUENCY DRIVES
   3. SECTION 26 32 13: GENERATOR SETS
   4. SECTION 26 36 23: AUTOMATIC TRANSFER SWITCHES
   5. SECTION 26 44 00: ELECTRICAL HEAT TRACING SYSTEMS
   6. SECTION 27 10 00: STRUCTURED CABLING SYSTEM
   7. SECTION 27 60 00: SCADA SYSTEM
   8. SECTION 27 60 05: SCADA INSTRUMENTATION

3.20. OPERATION AND MAINTENANCE DATA

A. One set of marked “AS BUILT” drawings, three (3) sets of all equipment catalog and maintenance data and three (3) sets of all final shop drawings, on all equipment requiring same shall be turned over to owner. These items shall be bound in hard back book. Contractor shall explain and demonstrate all systems to Owner’s representative.

3.21. GUARANTY-WARRANTY

A. Furnish a written Guarantee-Warranty, countersigned and guaranteed by General Contractor, stating:
   1. That all work executed under this section will be free from defects of workmanship and materials for a period of one (1) year from date of final acceptance of this work.
   2. Above parties further agree that they will, at their own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the term of the Guaranty-Warranty.

END OF SECTION 26 05 00

SECTION 26 05 19 - POWER CONDUCTORS AND CABLES 51V-600V

PART 1 - GENERAL

1.1. DESCRIPTION

A. Power Wires and Cables
B. Low Voltage Wires and Cables

PART 2 - PRODUCTS

2.1. POWER WIRES AND CABLES - 600 VOLT

A. General: Conductors shall have current carrying capacities as per N.E.C. and with 600 volt insulation, #12 minimum except for controls and fixture wire. Conductors shall be copper.
B. General Application (see below for exceptions):
    1. At or Below Grade (including within slab-on-grade):
        a. #8 or larger conductors:
            1) XHHW or RHH/RHW/USE stranded (in conduit).
        b. #10 or smaller conductors for circuits terminating at motors:
            1) THHN/THWN or XHHW stranded (in conduit).
        c. #10 or smaller conductors (excluding circuits terminating at motors):
            1) THHN/THWN or XHHW solid (in conduit).
    2. Above Grade:
        a. #8 or larger conductors:
            1) THHN/THWN, XHHW or RHH/RHW/USE stranded (in conduit).
        b. #10 or smaller conductors for circuits terminating at motors:
            1) THHN/THWN, XHHW or RHH/RHW/USE stranded (in conduit).
        c. #10 or smaller conductors (excluding circuits terminating at motors):
            1) THHN/THWN, XHHW or RHH/RHW/USE solid (in conduit).
    3. Power Wire and cable shall be as manufactured by Southwire, Rome, Encore Wire, American Insulated Wire, Okonite, Phelps-Dodge, Amercable, Aetna or approved equal.

C. VFD Cabling
    1. Wiring/Cabling installed between each VFD (Variable Frequency Drive) and the associated motor shall be multi-conductor shielded VFD power cable with the following characteristics:
        a. Multi-conductor cable with three (3) power conductors and three (3) ground conductors
        b. Soft annealed flexible stranded copper conductors.
        c. 1kV cross-linked polyolefin insulation (to resist the potential reflected voltages experienced in 600VAC VFD applications).
        d. Metallic shielded providing 100% shield coverage
        e. Oil, abrasion, chemical & sunlight resistant thermosetting compound outer jacket.
        f. Flexible TC-ER rated, UL listed for use in cable trays.
        g. Equal to AmerCable #37-108VFD cable.

D. Emergency Feeder Wiring

1. Where specifically required by NEC articles 700, 701, or other similar sections, feeder-circuit wiring for emergency systems and legally-required standby systems shall be a listed electrical circuit protective system consisting of 2-hour fire-rated, mineral insulated, copper-sheathed wiring cable (Pyrotenax System 1850 or equal).

E. Class 1 Control Cabling (120VAC Control Circuits, Etc.)
   1. Unless specified otherwise, Class 1 control cabling shall:
      a. Be rated for exposed cable tray installation.
      b. Be plenum rated (Class 1 Control cabling and Instrumentation cabling installed in conduit or exposed in cable tray in non-plenum areas is not required to be plenum-rated).
      c. Be UL-rated for the proposed application.
      d. Be multi-conductor with overall outer sheath as required by the application. The insulation of each conductor within the overall multi-conductor cable shall be uniquely color-coded. Ground conductors (when provided) within the multi-conductor cable shall have green insulation. Conductors with green insulation shall not be used for conductors other than ground.
      e. Utilize copper conductors.
      f. Have wire gauge as required to limit voltage drop to acceptable limits determined by the system supplier and to meet all applicable code requirements.
      g. Where installed underground, within slab-on-grade or in exterior locations, be rated for wet locations.
      h. Where required for specific systems, meet the specific requirements (conductor quantity, wire gauge, insulation type, shielding, etc.) of the system supplier.
      i. Be rated for 600V.
      j. Be industrial grade.
      k. Have stranded conductors.
      l. Have sunlight/oil-resistant PVC/Nylon insulation and jacket with ripcord.
   2. Control cabling shall be as manufactured by Belden, AlphaWire or General Cable.

F. Fixture Wiring
   1. Conductor Types:
      a. Type TFFN or XFF.
   2. Minimum Sizes:
      a. For fixtures up to 300 watts: #16.
      b. For fixtures over 300 watts up to 1500 watts: #14.
      c. For fixtures over 1500 watts: as required.
      d. Conductors to concrete pour fixtures: #12.
   3. Fixture wire shall extend only from fixture to first junction, and not over 6 feet, except for concrete pour units.

2.2. WIRE CONNECTIONS:

A. All connector types:
   1. Shall be properly rated for the proposed application by UL and per the manufacturer.

B. At Motor Connections (within motor terminal boxes):

1. On Unshielded Wire:
    a. Single conductor per phase: shall be made with insulated set screw connectors or 3M 5300 Series 1kV Motor Lead Connections kits with mechanical lugs as required.
    b. Multiple conductors per phase: shall be made with insulated mechanical lugs, rated for the associated motor cable types, by Polaris or Ilsco.
2. On Shielded Power Wire:
    a. The braided shields and internal grounding conductors of shielded power (not instrumentation) cables shall be grounded at BOTH ends (at VFD/starter and at motor) with a termination kit provided by the cable supplier. This termination kit shall include a connection ring that makes contact around the full circumference of the braided shield, and connects all internal grounds to a common external ground point.

C. Other Dry locations:
1. On Wire larger than #10: shall be made with solderless, non-insulated compression-type connectors meeting requirements of Federal Specification WS-610e for Type II, Class 2 and shall be covered with Scotch #33 electrical tape so that insulation is equal to 150% of conductor insulation.
2. On Wire #10 and smaller: shall be made with one of the following:
    a. Ideal Wing Nuts or equal by 3M .
    b. Ideal Push-In Wire Connectors (for #12 and smaller only).

D. Other Wet/Damp locations:
1. On Wire larger than #10: shall be made with underground/direct-burial, waterproof rated EPDM or TPE-insulated connectors by Ilsco, Burndy or T&B.
2. On Wire #10 and smaller: shall be made with one of the following:
    a. Ideal Weatherproof or Underground Wire Connectors pre-filled with 100% silicone sealant as required by the application.

PART 3 - EXECUTION

3.1. GENERAL INSTALLATION

A. All wires and cables shall be installed in conduit unless specifically noted otherwise.
B. All joints and splices on wire shall be made with solderless connectors, and covered so that insulation is equal to conductor insulation.
C. No splices shall be pulled into conduit.
D. No conductor shall be pulled until conduit is cleaned of all foreign matter.
E. Wire and cable shall be neatly formed, bundled and tied in all panelboards, wireways, disconnect switches, pullboxes, junction boxes, cabinets and other similar electrical enclosures.
F. All wires and cables installed in underground or other wet locations shall be rated by the manufacturer for wet locations.
G. Network cabling shall be continuous from endpoint to endpoint and shall not be spliced unless specifically noted otherwise.
H. All conductors/cabling (including spare conductors) shall be properly terminated unless specifically directed otherwise. See above for general termination hardware requirements.

3.2. POWER WIRE AND CABLE INSTALLATION:

A. No power conductor shall be smaller than #12 except where so designated on the drawings or hereinafter specified.
B. Multi-wire lighting branches shall be used as indicated.
C. Where more than three current-carrying conductors are installed in a single raceway or cable, conductors shall be derated as indicated in NEC Table 310.15(B)(3)(a).
D. Raceways/cables shall generally not be installed exposed to sunlight on roofs unless specifically required. Where raceways or cables are installed exposed to sunlight on roofs, conductors shall be derated with ampacities adjusted per NEC Table 310.15(B)(3)(c).
E. In installing parallel power conductors, it is mandatory that all conductors making up the feeder be exactly the same length, the same size, the same type of conductor with the same insulation. Each group of conductors making up a phase or neutral must be bonded at both ends in an approved manner.
F. In installing overhead main power services, a minimum of 5'-0" of cable per run shall be extended beyond the weatherhead(s) for connection to service drop. Confirm exact requirements with local utility company.

3.3. WIRE CONNECTIONS

A. See Part 2 above for material types.
B. Aluminum Wire Connections:
    1. Where aluminum wiring is allowed, connections shall utilize compression fittings, no exceptions (Anderson Versa Crimp or equal).

C. Any stranded wire connection to wiring devices shall be made with crimp type terminals.
D. All electrical connections and terminals shall be tightened according to manufacturer's published torque-tightening values with calibrated torque wrenches as required to clearly indicate final torque value to the contractor. Where manufacturer's torque values are not provided, those specified in UL 486A & 486B shall be used.
E. All connections and connector types shall be installed in strict compliance with all requirements of the connector manufacturer.
F. Under no condition shall the specified conductors be connected to terminals rated less than 75°C. Where conductors sized #1 or smaller are shown to be terminated at equipment and the terminals of that equipment are rated for less than 75°C, contractor shall install junction box near equipment to capture the specified conductors, splice with compression connections (rated for a least 75°C) and extend conductors with ampacity rating as required by NEC (based on terminal temperature rating) to equipment terminals. The length of the conductors to be terminated shall be as directed by the AHJ but not less than 48 inches.

3.4. SHIELDED CABLE INSTALLATION

A. Shielded VFD (power) cables:
    1. The braided shields and internal grounding conductors of shielded VFD (power) cables shall be grounded at BOTH ends (at VFD and at motor) with a termination kit provided by the cable supplier. This termination kit shall include a connection ring that makes contact around the full circumference of the braided shield, and connects all internal grounds to a common external ground point.
    2. Contractor shall coordinate the necessary size of conduit with the outer diameter of the proposed cable type to verify that the raceway loading does not exceed NEC requirements prior to rough-in of the conduit system.

B. Shielded instrumentation (low voltage) cables:
   1. The outer foil of shielded instrumentation cables shall be grounded at the PLC/control panel end only (not at the field device end) with a termination kit as directed by the PLC/control panel supplier.

3.5. LOW VOLTAGE (LESS THAN 50V) CONTROL AND NETWORK CABLE INSTALLATION:

A. All wires and cables shall be installed in conduit unless specifically noted otherwise. Low voltage control and/or network cabling located within concealed, accessible ceiling spaces (such as above lay-in ceilings) may be run without conduit if the following requirements are met:
   1. Cabling shall be plenum-rated, multi-conductor.
   2. Cabling shall be supported by cable tray or with J-hook supports on intervals not to exceed 5'-0" on center. Cabling shall be supported solely from the cable tray or j-hooks supported from the building structure, without using piping, ductwork, conduit or other items as supports.
   3. Cabling shall be properly bundled with plenum-rated Velcro straps on intervals not to exceed 30" on center.
   4. Properly-sized conduit(s) shall be provided wherever cabling enters an inaccessible or exposed area (such as above gyp board ceilings or through walls). End bushings shall be provided on both ends of all raceway terminations. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly.

3.6. CIRCUITS AND BRANCH CIRCUITS

A. Outlets shall be connected to branch circuits as indicated on drawings by circuit number adjacent to outlet symbols, and no more outlets than are indicated shall be connected to a circuit.

3.7. LABELING AND COLOR CODING OF WIRE AND CABLE

A. Refer to Specification Section 26 05 53 for all labeling requirements.
B. A color coding system as listed below shall be followed throughout the network of branch power circuits as follows:

PHASE	120/208/240/ COLOR	120/240 HIGH LEG DELTA COLOR	277/480 VOLT COLOR
A	BLACK	BLACK	BROWN
B	RED	ORANGE (FOR HI-LEG)	ORANGE
C	BLUE	BLUE	YELLOW
NEUTRAL	WHITE	WHITE	GRAY
GROUND	GREEN	GREEN	GREEN

C. Where dedicated neutrals are installed for multi-wire branch circuits, the neutral conductors shall be color coded as follows:

PHASE	120/208/240/ COLOR	120/240 HIGH LEG DELTA COLOR	277/480 VOLT COLOR

NEUTRAL A	WHITE W/ BLACK TRACER	WHITE W/ BLACK TRACER	GRAY W/ BROWN TRACER
NEUTRAL B	WHITE W/ RED TRACER	WHITE W/ ORANGE TRACER (FOR HI-LEG NEUTRAL)	GRAY W/ ORANGE TRACER
NEUTRAL C	WHITE W/ BLUE TRACER	WHITE W/ BLUE TRACER	GRAY W/ YELLOW TRACER

D. Control Conductors: Shall be color coded by use of colored “tracers”. No control circuit shall contain two identical conductors. For example, a set of five (5) control conductors for a pushbutton station represents one (1) control circuit which would require five (5) uniquely-colored control conductors.

3.8. TESTING

A. The insulation resistance of all feeder conductors (feeding electrical distribution equipment such as switchboards, panelboards, transfer switches, transformers, etc.) shall be tested at the load side of the feeder breaker with a 1000-volt DC Megger Tester prior to energization or final termination. Any feeder conductor with an insulation resistance less than the recommended minimums in the latest version of NETA Acceptance Testing Specification (“ATS”) standard shall be replaced by the contractor at the contractor’s expense. All final test results shall be clearly documented (with date, time, feeder, results, test equipment, etc.), and the final test results shall be submitted to the design team for review.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING

PART 1 - GENERAL

1.1. GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO GROUNDING OF THE FOLLOWING:
   1. Service Equipment.
   2. Transformers.
   3. Non-current carrying conductive surfaces of equipment.
   4. Metal Buildings.
   5. Structures.
   6. Other Equipment.

1.2. GENERAL REQUIREMENTS

A. All equipment, building steel, and main service shall be effectively and permanently grounded with a conductor cross section as required by the National Electrical Code and of capacity sufficient to insure continued effectiveness of the ground connections for fault current. Ground conductors shall be as short and straight as possible, protected from mechanical injury and, if practicable, without splice or joint.

B. All grounding connections shall be installed in accordance with the National Electrical Code and all local codes and requirements. Such codes shall be considered minimum requirements and the installation of the grounding system shall insure freedom from dangerous shock voltage exposure and provide a low impedance ground fault path to permit proper operation of overcurrent and ground fault protective devices.

PART 2 - PRODUCTS

2.1. CONDUCTORS

A. All grounding conductors shall be insulated with green colored, 600 volt insulation unless noted otherwise.

B. Motors having power supplied by single conductor wire in conduit shall be grounded through the conduit system. Flexible conduit shall be “jumpered” by an appropriate bonding conductor.

C. Supplemental grounding system conductors shall be bare, softdrawn, stranded, single conductor copper wire, and generally sized as follows (unless shown otherwise on plans):
   1. Switchgear, motor control centers, and power transformer #4/0 minimum or as shown on plans.
   2. Power panels, #2/0.
   3. Control panels and consoles, #4.
   4. Process Motors, #1/0.
   5. Building Columns, #4/0.
   6. Light Poles, #2.
   7. Telephone Backboard & Cabinet ground busses, #2.

2.2. GROUNDING ELECTRODES

A. Grounding electrodes shall be copper-clad steel rods 3/4 inch in diameter and ten feet long. Where longer electrodes are necessary to reduce the ground resistance, Contractor shall provide sectional rods, connectors, drive heads, etc.

2.3. CONNECTIONS

A. All conductor-to-conductor, conductor-to-ground rod, conductor-to-structure, conductor-to-fence connections of #6 and larger sized conductors and underground ground connections shall be permanent exothermic welded connections (Cadweld or equal) unless otherwise noted on applicable drawings.
B. Connections to equipment shall be by bolted compression type lugs (except for motors). When the conductor is #6 and larger, the lug shall be joined to the conductor by an exothermic weld (Cadweld or equal).
C. Motors to be grounded by the grounding conductors run with the power conductors shall have a split-post grounding stud installed in the connection box.
D. Each cast pull box or junction box shall have a ground lug, connected to largest ground conductor to enter box.
E. Ground connections at conduit terminations shall be made by approved grounding bushings (see Raceways Specification Section for additional requirements).

2.4. MANUFACTURERS

A. Conduit clamps and connectors shall be manufactured by Raco, OZ., or Ercon.
B. Lugs shall be as manufactured by Square “D”, Burndy, or T and B.
C. Exothermic weld connections shall be as manufactured by Cadweld, or approved equal.
D. Ground rods shall be as manufactured by Joslyn or McGraw Edison.
E. Split post grounding shall be as manufactured by Burndy or T and B.

PART 3 - EXECUTION

3.1. MAIN SERVICE GROUND

A. The main service grounding electrode system shall consist of the following items bonded together by the grounding electrode conductor:
    1. The main underground cold water pipe (metal).
    2. The metal frame of the building.
    3. Driven ground rods. Ground rods shall be embedded at the lowest point in the building and below the permanent moisture level. Ground rods shall be spaced a minimum of ten (10) feet apart and connected in parallel until resistance to ground does not exceed five (5) ohms.

B. The grounding electrode system shall be connected to the grounded conductor (neutral) on the supply side of the service disconnecting means by a grounding electrode conductor not smaller than that shown in Table 250.66 of the N.E.C. The main service equipment grounding conductor shall be connected to the grounding conductor on the supply side of the service disconnecting means in accordance with Table 250.122 of the N.E.C. for the ampere rating of the service entrance equipment. Where in a service entrance switchboard, the equipment grounding conductor shall not be less than 25% of the main bus rating. These connections shall be made inside the service entrance equipment enclosure.

3.2. TRANSFORMER GROUNDS

A. Dry type insulation transformers with a grounded conductor in the secondary shall be grounded in accordance with N.E.C. Section 250-30.

3.3. EXPOSED NON-CURRENT-CARRYING METAL PARTS

A. General: Ground connections to equipment or devices shall be made as close to the current carrying parts as possible, that is, to the main frame rather than supporting structures, bases or shields. Grounding connections shall be made only to dry surfaces that are clean and dry. Steel surfaces shall be ground or filed to remove all scales, rust, grease, and dirt. Copper and galvanized steel shall be cleaned to remove oxide before making welds or connections. Code size ground conductors shall be run in all power conduits and properly terminated at each end.
B. Ground conductors shall be routed as straight as possible. Where possible, ground conductors shall be routed such as to avoid bends exceeding 90 degrees or with a radius of less than 8".
C. Motors: Exposed non-current-carrying metal parts, shall be grounded by a grounding conductor either run with power conductors, and/or separate grounding conductors. Drawings will show method(s) to be used. The ground conductors with all motor conductors shall be connected to the ground buss in the motor connection box. Jumper connections shall be installed between frames and rigid conduit for equipment having flexible conduit connections (sealtight). All AC motor grounds shall provide a low impedance path to ground. Connections from the supplemental grounding system (when specified) shall be made directly to the motor frame. Additionally, utilization equipment connected to the motor (pump, fan, mixer, etc.) shall be bonded to the motor with flexible braid-type bonding strap to ensure equalization of ground potentials.
D. Raceways & boxes: All raceways, conduits, armored or shielded cable and all exposed non-current carrying metal parts shall be grounded. Such items shall be bonded together and permanently grounded to the equipment ground buss. Metallic conduits shall be connected by grounding or clamps to ground buss. Flexible "jumpers" shall be provided around all raceway expansion joints. Bonding straps for steel conduit shall be copper. Jumper connections shall be provided to effectively ground all sections or rigid conduit connected into plastic pipe. No metallic conduit shall be left ungrounded. In conduit systems interrupted by junction or switch boxes where locknuts and bushings are used to secure the conduit in the box, the sections of conduit and box must be bonded together. If conduit, couplings or fittings have a protective coating or non-conductive material, such as enamel, such coating must be thoroughly removed from threads of both couplings and conduit and the surface of conduit or fitting where the ground clamp is secured.
E. Enclosures: Metal conduits entering free standing motor control centers, switchboards or other free standing equipment shall be grounded by bare conductors and approved clamp. Any conduits entering low voltage (480 volts or below) equipment through sheet metal enclosure and effectively grounded to enclosure by double locknut or hub need not be otherwise bonded.
F. Equipment: In addition to equipment grounding provisions mandated by code requirements, additional equipment grounding provisions (including local ground rods, connections, etc.) shall be provided by the contractor as directed by equipment suppliers.
G. Both ends of ground busses in motor control centers, switchboards, etc., shall be separately connected to the main ground buss to form two separate paths to ground.
H. Fences and Grills: Fences and metal grills around equipment carrying voltage above 500 volts between phases shall be bonded together and to ground. Fences and grill

work shall be grounded at every post, column, or support, and on each side of every gate.

3.4. ACCEPTANCE DOCUMENTATION AND TESTING

A. Contractor shall take and store photographs of all underground grounding system connections prior to burial of connections, for review by Engineer.
B. Upon completion of work, the entire ground system shall be shown to be in perfect working condition, in accordance with the intent of the Specifications.
C. Contractor shall measure the resistance between the main ground bonding jumper to true earth ground using the Fall of Potential method as described by ANSI/IEEE Standard 81 (“Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of an Earth System”). If the measured value is greater than five ohms, additional grounding electrodes shall be installed as described in Part 3.1 above. The final ground resistance value shall be submitted in writing, and documented via picture of the meter reading from the Fall of Potential test, to the Engineer prior to the final observation, and shall be included in final O&M documentation.

END OF SECTION 26 05 26

SECTION 26 05 33 - RACEWAYS

PART 1 - GENERAL

1.1. DESCRIPTION

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:
   1. Conduits
   2. Conduit Fittings
   3. Couplings & Connectors
   4. Bushings
   5. Raceway Hardware, Conduit Clamps & Supports
   6. Watertight Entrance Seal Devices

PART 2 - PRODUCTS

2.1. CONDUITS

A. PVC-Coated Rigid Steel:
   1. The PVC coated rigid metal conduit must be UL Listed. Hazardous location fittings, prior to plastic coating must be UL listed. All conduit and fittings must be new, unused material. Applicable UL standards may include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.
   2. The PVC-coated rigid metal conduit shall be ETL PVC-001 listed.
   3. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.
   4. Form 8 Condulets®, 3/4" through 2" diameters, shall have a tongue-in-groove “V-Seal" gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be available.
   5. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.
   6. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.
   7. Form 8 Condulets® shall be supplied with plastic encapsulated stainless steel cover screws.
   8. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.
   9. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30deg.F (-1deg.C).
   10. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.

11. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.
12. Independent certified test results shall be available to confirm coating adhesion per ETL PVC-001 standards under the following conditions:
    a. Conduit immersed in boiling water with a minimum mean time to adhesion failure of 200 hours. ASTM D870)
    b. Conduit and condulet exposure to 150deg F (65deg C) and 95% relative humidity with a minimum mean time to failure of 30 days. (ASTM D11513.
    c. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
    d. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
    e. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1.
    f. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.
13. Water tight flex connectors used in areas where PVC coated metal conduit is utilized shall be PVC coated also.
14. Shall be as manufactured by Perma-Cote, Plastibond, Korkap, Ocal or Okote.

B. Rigid Galvanized Steel and I.M.C.:
    1. Shall be galvanized outside and inside by hot dipping.
    2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

C. E.M.T.:
    1. Shall be Electro-Galvanized.
    2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

D. Rigid Aluminum:
    1. Shall be manufactured of 6063 Alloy, T-1 temper.
    2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

E. Schedule 40 and 80 PVC:
    1. Shall be composed of polyvinyl chloride and shall be U.L. rated type 40 or 80 for use with 90 degree rated conductors. Conduit shall conform to NEMA Standards and applicable sections of N.E.C.
    2. The conduit manufacturer shall have had a minimum of 5 years experience in the manufacture of the products. Non-metallic raceways shall be as manufactured by Carlon, Triangle, Can-Tex, Allied or equal.

F. HDPE Innerduct
    1. Shall be composed high density polyethylene and shall be orange in color, unless noted otherwise.
    2. Shall be corrugated unless noted otherwise.
    3. Shall be manufactured by Carlon, Ipex or equal.

G. Flexible Metallic Conduit:
    1. Shall be continuous spiral wound and interlocked galvanized material, code approved for grounding.

H. Liquidtight Flexible Metallic Conduit:
   1. Shall be galvanized steel-core sealtite, code approved for grounding.
   2. Shall have an outer liquidtight, nonmetallic, sunlight-resistant jacket over an inner flexible metal core.
   3. Shall be as manufactured by Electric-Flex, Anaconda or equal.

2.2. FITTINGS, COUPLINGS & CONNECTORS

A. Rigid Galvanized Steel and I.M.C. couplings and connectors shall be standard threaded type, galvanized outside and inside by hot dipping. Threadless and clamp type are not acceptable. Couplings/connectors shall be as manufactured by Raco, Efcor, or Appleton or equal.
B. All fittings, couplings and connectors (including, but not limited to, conduit couplings, connectors, hubs, nipples, unions, expansion fittings, explosion proof seal-offs, threaded hole closures, and seal-tight connectors, etc.) used in areas where PVC-Coated Rigid conduit is used shall also be PVC-coated.
C. All fittings, couplings and connectors (including, but not limited to, conduit couplings, connectors, hubs, nipples, unions, expansion fittings, explosion proof seal-offs, threaded hole closures, and seal-tight connectors, etc.) installed in other wet, exterior or process areas where PVC-coated conduit systems are not required, shall be aluminum or stainless steel type. Standard steel fittings will not be acceptable.
D. All rain tight connectors shall be threaded Myers or approved equal, rated for outdoor application.
E. E.M.T. couplings and connectors shall be set screw, or steel compression type. All couplings and connectors shall be 720B, 730, 750B, or 760 series of Efcor or equal series of Raco. Pressure indented type connectors or cast metal will not be approved for any location. E.M.T. couplings and connectors shall be as manufactured by O-Z/Gedney, T&B, Efcor, Raco, Midwest or equal. E.M.T. fittings, couplings and connectors located within concrete (where allowed) shall be compression type and shall be adequately sealed with tape to ensure a concrete-tight seal.
F. Rigid Aluminum couplings and connectors shall be standard threaded type, of the same alloy as the associated conduit. Threadless and clamp type are not acceptable. Fittings shall be as manufactured by Thomas & Betts, Crouse-Hinds, Appleton, Pyle-National or equal.
G. All PVC couplings, adapters, end bells, reducers, etc., shall be of same material as conduit.
H. Liquidtight Flexible Metallic Conduit connectors shall be liquidtight with insulating throat or end bushing, designed for application with Liquidtight Flexible Metallic Conduit. Fittings shall be as manufactured by Efcor, Raco, Midwest or equal.
I. All LB unilets sizes 1 ¼" or larger shall have rollers.
J. Miscellaneous conduit fittings shall be as manufactured by Appleton, Crouse-Hinds, Pyle-National, Russell & Stoll or equal.

2.3. BUSHINGS

A. All non-grounding rigid bushings 1-1/4" and larger shall be the insulating type (O-Z/Gedney type "BB" or equal by T&B, Midwest Electric or Penn Union).
B. All non-grounding rigid bushings 1" and smaller shall be threaded malleable iron with integral noncombustible insulator rated for 150°C. Non-grounding rigid conduit bushings shall be O-Z/Gedney type "B" or equal by T&B, Midwest Electric or Penn Union.
C. All grounding rigid bushings shall be threaded malleable iron with integral

noncombustible insulator rated for 150°C. All grounding rigid conduit bushings shall be O-Z/Gedney type “BLG” or equal by T&B, Midwest Electric or Penn Union.

2.4. HARDWARE, CONDUIT CLAMPS AND SUPPORTS

A. All hardware such as expansion shields, machine screws, toggle bolts, “U” or “J” bolts, machine bolts, conduit clamps and supports shall be of corrosion resistant materials (stainless steel, aluminum, galvanized or plated steel, or other approved materials).
B. Hardware in contact with aluminum handrails, plates or structural members and all hardware in exterior, wet or corrosive areas shall be type 316 stainless steel or aluminum (with bitumastic paint coating to isolate aluminum from contact with concrete where necessary) unless specifically noted otherwise.
C. Supports in exterior, process, wet or corrosive locations shall be type 316 stainless steel or aluminum (with bitumastic paint coating to isolate aluminum from contact with concrete where necessary) unless specifically noted otherwise.
D. Supports in extremely corrosive environments (such as chlorine or fluoride storage rooms) shall be PVC-Coated steel unless specifically noted otherwise.
E. Hardware and conduit clamps shall be as manufactured by Efcor, Steel City, G.A., Tinnerman or equal.

2.5. WATERTIGHT ENTRANCE SEAL DEVICES

A. For new construction, seal devices shall consist of oversized sleeve and malleable iron body with sealing rings, pressure rings, sealing grommets and pressure clamps as required (O-Z/Gedney type FSK/WSK or equal).
B. For cored-hole applications, seal devices shall consist of assembled dual pressure disks with neoprene sealing rings and membrane clamps as required (O-Z/Gedney type CSM or equal).

PART 3 - EXECUTION

3.1. RACEWAY APPLICATION

A. Minimum Diameter: 3/4-inch.
B. Raceway Type: Raceway types shall be as specified below, unless indicated otherwise on drawings:
    1. Exterior, Exposed: Rigid Aluminum unless otherwise noted.
    2. Exterior, Used for Instrumentation Circuits: See Below.
    3. Other Exterior (Concrete-Encased or Direct Earth Buried): Schedule 40 PVC. PVC conduit shall convert to metallic conduit prior to exiting concrete-encasement or direct earth burial. See “transition” items below for additional requirements. Conduits shall be left exposed until after Engineer’s observation.
    4. Interior, Exposed:
        a. Hazardous Locations: Rigid Aluminum .
        b. Wet Locations (including, but not limited to, Pump Rooms, Areas with exposed piping, Dewatering Rooms, Wet Wells, Underground Vaults, and other similar locations): Rigid Aluminum .
        c. Dry Locations: Rigid Aluminum.
        d. Extremely Corrosive Locations (Chlorine Storage Rooms, Fluoride Storage Rooms and other similar areas): Schedule 80 PVC.
    5. Interior, Concealed:

a. Embedded inside Poured Concrete Walls, Ceilings or Floors, with a minimum of 2” of concrete between finished surface and outer wall of conduit on all sides, where no anchor bolts, screws or other similar items will be installed: Schedule 40 PVC. PVC conduit shall convert to metallic conduit (exact type as specified elsewhere within this section) prior to exiting poured concrete-encasement of wall, ceiling, floor or ductbank. See “transition” items below for additional requirements.
b. Other Raceways Embedded inside Poured Concrete Walls, Ceilings or Floors (not meeting requirements above): PVC-Coated Rigid Steel
c. Other Raceways: E.M.T.

6. Raceways used for Instrumentation Circuits:
   a. Typical Dry or Wet Locations: Rigid Aluminum .
   b. Underground or Locations Embedded inside Poured Concrete: PVC-Coated Rigid Steel.
   c. Extremely Corrosive Locations (Chlorine Storage Rooms, Fluoride Storage Rooms and other similar areas): PVC-Coated Rigid Steel.
7. Terminations at motors, transformers and other equipment which has moving or vibrating parts:
   a. Exterior or Wet Locations (including, but not limited to, Pump Rooms, Wet Wells, Underground Vaults, and other similar locations): Liquidtight Flexible Metallic Conduit (shall generally not exceed 24 inches in length) with watertight fittings.
   b. Dry, Interior Locations: Flexible Metallic Conduit (shall generally not exceed 24 inches in length).
8. Terminations at instruments:
   a. Liquidtight Flexible Metallic Conduit (shall generally not exceed 12 inches in length) with watertight fittings.
9. Terminations at fixtures mounted in grid-type ceilings:
   a. Flexible Metallic Conduit or MC cabling (shall generally not exceed 72 inches in length and shall run from junction box to fixture, not from fixture to fixture).
10. Transition from underground or concrete-encased to exposed:
    a. Convert PVC to PVC-Coated Rigid Steel utilizing PVC-Coated Rigid Steel 90 degree bends (and vertical conduits as required by application) prior to exiting concrete/grade (except at outdoor pull boxes and under freestanding electrical equipment, where terminations shall be by PVC end bells installed flush with top of slab). Exposed portions of these coated conduits shall extend a minimum of 6” above floor level, and shall be installed at uniform heights.

3.2. RACEWAY INSTALLATION

A. General:
   1. Follow methods which are appropriate and approved for the location and conditions involved. Where not otherwise shown, specified, or approved in a particular case, run all wiring concealed.
   2. Where conduit crosses a structural expansion joint an approved conduit expansion fitting shall be installed.
   3. Where any run of rigid aluminum conduit (including bends) exceeds 50’ in length, an approved conduit expansion fitting shall be installed (beginning at center of run) at intervals not to exceed 50’ on center.

4. A non-conductive polypropylene pull string, properly tied/secured at either end, shall be installed in all empty conduits.
5. Metal conduit field-cuts shall be cut square with a hacksaw and the ends reamed after threading.
6. PVC conduit field-cuts shall be made with hacksaw, and ends shall be deburred.
7. All PVC joints shall be made as follows:
    a. Clean the outside of the conduit to depth of the socket, and the inside of socket with an approved cleaner.
    b. Apply solvent cement as recommended by the conduit manufacturer to the interior of the socket and exterior of conduit, making sure to coat all surfaces to be joined.
    c. Insert conduit into the socket and rotate 1/4 to 1/2 turn and allow to dry.
8. All metallic conduit installed below grade or within concrete shall be coated with two (2) spiral-wrapped layers of 3M Scotchrap 50 PVC tape or two coats of asphaltum paint prior to installation.
9. Install ground wire sized per N.E.C. Table 250.122 in all conduits.
10. Use of running threads is absolutely prohibited. Conduit shall be jointed with approved threaded conduit couplings. Threadless and clamp type not acceptable.
11. Conduits shall be sized in accordance with latest National Electrical Code except when size shown on drawings.
12. Exposed, field-cut threads on all metal conduits shall be painted with zinc primer (for Galvanized Rigid or I.M.C.) or urethane paint (for PVC-Coated Rigid Steel) as recommended by conduit manufacturer .
13. Installation of PVC coated conduit systems shall be performed in strict accordance with the manufacturer's installation instructions. Damage to PVC coated conduit coating shall be touched up with patching compound as directed by manufacturer. To assure correct installation, the installer shall be certified by the manufacturer to install coated conduit.

B. Routing/Locating:
1. Exposed conduit runs shall be run level and plumb and shall, on interior of buildings, be run parallel and/or at right angles to building walls and/or partitions.
2. Conduit with an external diameter larger than 1/3 the thickness of a concrete slab shall not be placed in the slab. Conduits in slab shall not be spaced closer than 3 diameters on center.
3. Conduit run in ceiling spaces shall be run as high as possible, all at same level, and shall be supported from building structure. Do not support conduit from any other installation.
4. Conduit run within exterior CMU, concrete or other similar walls shall be run within the CMU cells / concrete structure / etc. Conduits shall not be run on the outside surface of CMU cells / concrete structure / etc. underneath exterior veneers / etc., which could cause a thermal break in the wall insulation or a future water intrusion problem.
5. Install conduit runs to avoid proximity to steam or hot water pipes. In no place shall a conduit be run within 6" of such pipes except where crossing is unavoidable, then conduit shall be kept at least 3" from the covering of the pipe crossed.
6. Before installing raceways for motors, HVAC equipment and other fixed equipment, check location of all equipment connections/terminal boxes with equipment supplier and locate and arrange raceways appropriately.

7. No conduit for instrumentation shall be run closer than 12 inches to parallel power conduits.
8. A minimum of 12” of clearance (or more as required by associated utility companies) shall be provided between the finished lines of exterior, underground conduit runs and exterior, underground utilities (gas, water, sewer, etc.).
9. Where any portion of raceway is installed in a wet environment (such as below grade) and located at a higher elevation than the raceway termination point in a dry environment, install watertight compound inside raceway at termination around cabling to prevent transfer of water through conduit system. Watertight compound shall be rated for the potential water head pressure, based on the assumption that ground water level would be at grade level.

C. Bends:
1. Do not make bends (in any raceway, including flexible conduits) that exceed allowable conductor bending radius of cable to be installed or that significantly restrict conductor flexibility.
2. All bends within concrete-encased ductbanks installed in exterior locations shall be long radius bends (24” minimum bending radius – varies with conduit diameter).
3. All bends in raceways containing multi-conductor power cables (such as shielded VFD cables) shall be long radius bends (24” minimum bending radius – varies with conduit diameter).
4. Where numerous exposed bends or grouped together, all bends shall be parallel, with same center and shall be similar in appearance
5. All PVC elbows, bends, etc., shall be either factory bends or made with an approved heat bender.

D. Support:
1. Anchor conduit securely in place by means of approved conduit clamps, hangers, supports and fastenings. Arrangement and methods of fastening all conduits shall be subject to Engineer’s direction and approval. All conduits shall be rigidly supported (wire supports may not be used in any location). Use only approved clamps on exposed conduit.
2. Rigid Aluminum Conduits shall be supported at intervals not to exceed 5’ on center.
3. Conduit in riser shafts shall be supported at each floor level by approved clamp hangers.
4. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameters of conduits.
5. Where installed in seismic zones, suspended raceways shall be braced in two (2) directions as required to prevent swaying and excessive movement.
6. Raceways installed on top of flat roofing shall be supported a minimum of 3 ½” above roof with rubber block supports (Cooper B-Line Dura-Blok or equal). Installation shall be in strict accordance with support manufacturer’s instructions and recommendations.

E. Terminations:
1. All conduit connections to sheet metal cabinets or enclosures located in exterior or wet locations shall terminate by use of rain tight (Meyers) hubs.
2. In wet, exterior or process areas, conduits shall NOT enter tops of enclosures. All conduits shall enter enclosures from bottom, left or right sides of the enclosure (utilizing rain-tight Meyers hubs as indicated above).

3. Where rigid or I.M.C. conduits enter sheet metal boxes, they shall be secured by approved lock nuts and bushings.
4. Where metal conduits enter outdoor pull boxes, manholes, under freestanding electrical equipment or other locations where direct metal-to-metal contact does not exist between enclosure and conduit, grounding bushings shall be installed. Each grounding bushing shall be connected to the enclosure ground and all other grounding bushings with properly sized grounding conductors.
5. Where E.M.T. enters sheet metal boxes they shall be secured in place with approved insulating fittings.
6. Where PVC enters outdoor pull boxes, manholes or under freestanding electrical equipment, PVC end bells shall be installed.
7. Contractor shall be responsible for coordinating required conduit sizes with equipment hubs/conduit entry provisions (such as at motor tap boxes) prior to installation of conduit systems. Contractor shall field adjust final conduit sizes at terminations where so required (only as allowed by code) from those indicated on plans to coordinate with equipment hubs/conduit entry provisions.
8. Where conduit terminates in free air such that associated cabling/circuitry becomes exposed (such as at cable trays, etc.), conduit shall generally terminate in a horizontal orientation (to prevent dust/debris/etc. from entering conduit system). Where vertical conduit termination is necessary, the termination shall be provided with cord-grip conduit terminations to seal the conduit system.
9. Conduit ends shall be carefully plugged during construction.
10. Permanent, removable caps or plugs shall be installed on each end of all empty raceways with fittings listed to prevent water and other foreign matter from entering the conduit system.

F. Penetrations:
1. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly. Refer to drawings and other specifications for additional requirements.
2. All penetrations shall be at right angles unless shown otherwise.
3. Structural members (including footings and beams) shall not be notched or penetrated for the installation of electrical raceways unless noted otherwise without specific approval of the structural engineer.
4. Dry-packed non-shrink grout or watertight seal devices shall be used to seal openings around conduits at all penetrations through concrete walls, ceilings or aboveground floors.
5. All raceways entering structures, or where water is otherwise capable of entering equipment/devices through the raceway system, shall be sealed (at the first box or outlet) with foam duct sealant to prevent the entrance of gases or liquids from one area to another or into equipment/devices, using Polywater FST sealant rated to hold back a minimum of 22’ of continuous water head pressure (or equal).
6. Additionally, where necessary to ensure that water does not enter equipment/devices through the raceway system (where raceways extend to equipment/devices from wet areas), junction boxes with drain assemblies in bottom shall be located at low point of raceway system near equipment/devices (to drain water out of raceway system before it enters equipment/devices). Contractors shall provide drains in raceway systems where so necessary to prevent water entry into equipment/devices. In special applications (such as to instruments, etc.,), where cabling rated for exposed application is provided, contractor may propose short air gaps (approximately 6” or less) between the

end of the conduit system and the equipment/device cable entry (to be made with cable gland connectors) to prevent water in conduit system from entering equipment/devices in lieu of drained junction boxes.

7. All raceways passing through concrete roofs or membrane-waterproofed walls or floors shall be provided with watertight seals as follows:
   a. Where ducts are concrete encased on one side: Install watertight entrance seal device on the accessible side of roof/wall/floor as directed by equipment manufacturer.
   b. Where ducts are accessible on both sides: Install watertight entrance seal device on each side of roof/wall/floor as directed by equipment manufacturer.
8. All raceways passing through walls of rooms containing/storing noxious chemicals (chlorine, ammonia, etc.) or through hazardous locations shall be sealed with conduit seals (Crouse-Hinds type EYS or equal).
9. All raceways terminating into electrical enclosures/devices/panels/etc. located in hazardous locations shall be sealed with conduit seals (Crouse-Hinds type EYS, EZS or equal) within 18” of the termination.

G. Exterior Electrical Ductbanks:
   1. Where exterior electrical concrete-encased ductbanks are indicated on drawings, conduit runs between buildings or structures shall be grouped in concrete-encased ductbanks as follows:
      a. A minimum of 3” of concrete shall encase each side of all ductbanks.
      b. A minimum of 1 ½” of separation shall be provided between each conduit within ductbanks. PVC spacers shall be installed at the necessary intervals prior to placement of concrete to maintain the required spacing and to prevent bending or displacement of the conduits.
      c. Top of concrete shall be a minimum of 30” below grade. A continuous magnetic marking tape shall be buried directly above each ductbank, 12” below grade.
      d. Exact routing of ductbanks shall be field verified and shall be modified as necessary to avoid obstruction or conflicts.
      e. Underground electrical raceways shall be installed to meet the minimum cover requirements listed in NEC Table 300.5. Refer to drawings for more stringent requirements.

END OF SECTION 26 05 33

SECTION 26 05 34 - OUTLET BOXES, JUNCTION BOXES, WIREWAYS

PART 1 - GENERAL

1.1. DESCRIPTION

A. Outlet and Junction Boxes
B. Pull Boxes
C. Wireways

PART 2 - PRODUCTS

2.1. OUTLET BOXES & JUNCTION BOXES (THROUGH 4-11/16")

A. Sheet Metal: Shall be standard type with knockouts made of hot dipped galvanized steel as manufactured by Steel City, Raco, Appleton, Bowers or equal.
B. Cast: Shall be type FS, FD, JB, GS, or SEH as required for application as manufactured by O-Z/Gedney, Appleton, or equal.
C. Nonmetallic: Shall be type Polycarbonate/ABS construction as required for application with non-metallic quick-release latches as manufactured by Hoffman, O-Z/Gedney, Appleton, or equal.

2.2. JUNCTION AND PULL BOXES (LARGER THAN 4-11/16")

A. Oil-Tight JIC: Shall be Hoffman Type CH box or approved equal.
B. Galvanized Cast Iron or Cast Aluminum: Shall be O-Z/Gedney or approved equal.
C. Stainless Steel: Shall be as manufactured by O-Z/Gedney, Hoffman or approved equal. Boxes shall have continuous hinges, seamless foam-in-place gaskets and screw-down clamps.
D. Nonmetallic: Shall be type Polycarbonate/ABS construction as required for application with non-metallic quick-release latches as manufactured by Hoffman, O-Z/Gedney, Appleton, or equal. Boxes shall have hinged covers and screw-down clamps.
E. Wireways: Shall be standard manufacturer's item as manufactured by Hoffman, Square "D", Burns, B & C or equal. Wireways shall have hinged covers and screw-down clamps.
F. Pre-cast Polymer Concrete Below-Grade Hand Holes & Pull Boxes:
    1. Enclosures, boxes and cover are required to be UL Listed and conform to all test provisions of ANSI/SCTE 77 "Specifications For Underground Enclosure Integrity" for Tier 15 applications (15,000lb design load and 22,500lb test load) unless noted otherwise.
    2. All covers shall have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding Tier level shall be embossed on the top surface.
    3. Cover shall be bolt-down include factory-labeling to read "Electric", "Communications" or other as directed.
    4. Hardware shall be stainless steel.
    5. Shall be Quazite PG/LG Style or approved equal.

G. Galvanized Cast Iron Below-Grade Pull Boxes:
    1. Enclosures, boxes and cover are required to conform to AASHTO H-20 requirements for deliberate vehicular traffic applications unless noted otherwise.

2. Cover shall be checkered, bolt-down include factory-labeling to read “Electric”, “Communications” or other as directed.
3. Hardware shall be stainless steel.
4. Shall be furnished with grounding kit.
5. Shall be O-Z/Gedney Type YR or approved equal.

H. Above-Grade Padmounted Low Profile Pull Boxes:
   1. Construction:
      a. 12Ga. stainless steel base with 12Ga aluminum top with brushed finish, and structural bracing as required.
      b. Continuous base frame with open bottom and eight (8) ½” x 1” slots for securing box to concrete pad below and a center support member.
      c. Two (2) full-size swing-open lids with full-length, stainless steel continuous hinges, lifting handles, key-locking provisions and provisions for latching lids in open position (with stainless steel chain or approved equal).
      d. Guides on lid and base frame as required to insure proper closing of box and to provide increased security.
      e. Aluminum or stainless steel barrier between power & instrumentation areas within box if box is used for both power and instrumentation wiring.
      f. Other stainless steel hardware as required.
   2. Minimum Dimensions:
      a. Power: 40 inches square x 18 inches high.
      b. Instrumentation: 24 inches square x 18 inches high.
   3. Manufacturer:
      a. Electrical Enclosure Mfg. (Pell City, AL).
      b. Ebox (Pelham, AL).
      c. Approved Equal.

I. Above-Grade Padmounted Transclosure Pull Boxes:
   1. Construction:
      a. 12Ga.aluminum with brushed finish.
      b. Continuous top and bottom support frames with open bottom and slots as required for securing box to concrete pad below and a center support member.
      c. Roof with 1” crest on each unit and gutters between each unit.
      d. Vents (with screens) on top and bottom around perimeter of box.
      e. Full-size swing-out doors on two (2) opposing sides with weld-on barrel hinges (minimum of two per door) and key-locking “L”-handles with roller rods.
      f. Stainless steel barrier between power & instrumentation areas within box if box is used for both power and instrumentation wiring.
      g. Other stainless steel hardware as required.
   2. Minimum Dimensions:
      a. Power: 42 inches square x 42 inches high.
      b. Instrumentation: 42 inches square x 42 inches high.
   3. Manufacturer:
      a. Electrical Enclosure Mfg. (Pell City, AL).
      b. Ebox (Pelham, AL).
      c. Gilbert Electrical Systems
      d. Approved Equal.

PART 3 - EXECUTION

3.1. APPLICATION

A. General
   1. All boxes and wireways shall be of sufficient size to provide free space for all enclosed conductors per NEC requirements. Fill calculations shall be performed by contractor per NEC requirements.

B. Outlet Boxes & Junction Boxes (through 4-11/16”)
   a. Sheet metal boxes shall be used on concealed work in ceiling or walls.
   2. Cast boxes shall be used wherever Rigid or I.M.C. conduits are installed.
   3. All boxes installed in extremely corrosive areas (such as chlorine and fluoride storage rooms) where non-metallic raceways are used shall be non-metallic.
   4. Except when located in exposed concrete block, switch and receptacle boxes shall be 4" square for single gang installation. Appropriate gang boxes shall be used for mounting ganged switches.
   5. When installed in exposed concrete block, switch and receptacle boxes shall be square type designed for exposed block installation.
   6. Ceiling outlet boxes shall be 4" octagon 1-1/2" deep or larger required due to number of wires.
   7. Boxes installed in hazardous locations shall be explosion-proof rated for the associated application, constructed of copper-free cast aluminum.

C. Junction & Pull Boxes (larger than 4-11/16”)
   1. For all below grade exterior use and elsewhere as shown:
      a. In areas subject to future vehicular traffic: shall be galvanized cast iron (rated AASHTO H-20 Loading unless noted otherwise).
      b. In areas not subject to vehicular traffic: shall be galvanized cast iron or pre-cast polymer concrete (rated for Tier 15 Loading unless noted otherwise).
   2. All boxes installed exposed in exterior or wet areas shall be stainless steel (NEMA 4X).
   3. All boxes installed exposed in corrosive areas shall be stainless steel (NEMA 4X).
   4. All boxes installed in extremely corrosive areas (such as chlorine and fluoride storage rooms) where non-metallic raceways are used shall be non-metallic.
   5. Padmounted Pull Boxes shall be installed as shown on Plans or as required by project conditions. Transclosure-style Padmounted boxes shall be installed wherever required by the quantities and sizes of conductors. Contractor shall submit all Padmounted Pull Box types prior to ordering for engineer’s review and comment.
   6. Boxes installed in hazardous locations shall be explosion-proof rated for the associated application, constructed of copper-free cast aluminum.
   7. All others shall be oil tight JIC box not less than 16 gauge.

3.2. INSTALLATION

A. General
   1. All boxes and wireways shall be securely anchored.
   2. All boxes shall be properly sealed and protected during construction and shall be cleaned of all foreign matter before conductors are installed.
   3. All boxes and wireways shall be readily accessible. Contractor shall be responsible for furnishing and installing access panels per architect’s specifications. Locations shall be as directed by the architect as required to

make boxes, wireways, electrical connections, etc. accessible where above gypsum board ceilings or in other similar locations.
4. All metallic boxes and wireways shall be properly grounded.
5. Refer to Specification Section 26 05 53 for identification requirements.

B. Outlet Boxes & Junction Boxes (through 4-11/16”)
1. Boxes shall be provided with approved 3/8" fixture studs were required.
2. Recessed boxes for wiring devices, surface fixtures, or connections, shall be set so that the edge of cover comes flush with finished surface.
3. There shall be no more knockouts opened in any sheet metal box than actually used.
4. Any unused opening in cast boxes shall be plugged.
5. Back to back boxes to be staggered at least 3 inches.
6. Under no circumstances shall through-the-wall boxes be used.

C. Junction & Pull Boxes (larger than 4-11/16”)
1. Pull boxes shall be installed as indicated on plans and/or as required due to number of bends, distance or pulling conditions.
2. Boxes to be imbedded in concrete shall be properly leveled and anchored in place before the concrete is poured.
3. All pull boxes and/or junction boxes installed exterior below grade, shall have their tops a minimum of 1-1/2 inches above surrounding grade and sloped so that water will not stand on lid. A positive drain shall be installed, to prevent water accumulation inside.
4. Above grade pull boxes shall be installed on concrete anchor bases as shown on Plans.

D. Wireways and/or wall-mounted equipment
1. Mount each wireway to channels of the same metal type as the wireway.
2. Conductors serving a wireway shall be extended without reduction in size, for the entire length of the wireway. Tap-offs to switches and other items served by the wireway shall be made with ILSCO type GTA with GTC cap.

END OF SECTION 26 05 34

SECTION 26 05 36 - CABLE TRAYS

PART 1 - GENERAL

1.1. SECTION INCLUDES

A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete cable tray systems as shown on the drawings.
B. Cable tray systems are defined to include, but are not limited to straight sections of cable trays, bends, tees, elbows, drop-outs, supports and accessories.

1.2. REFERENCES

A. ANSI/NFPA 70 - National Electrical Code
B. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
C. ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
D. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability *(Formerly ASTM A570 &A607)*
E. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability *(Formerly ASTM A611)*
F. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
G. NEMA VE 1-2002 - Metallic Cable Tray Systems
H. NEMA VE 2-2006 - Cable Tray Installation Guidelines
I. TIA 569-A – Commercial Building Standard for Telecommunications Pathways & Spaces

1.3. DRAWINGS

A. The drawings, which constitute a part of these specifications, indicate the general route of the cable tray systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc., is directed.
B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.4. SUBMITTALS

A. Submittal Drawings: Submit drawings of cable tray and accessories including clamps, brackets, hanger rods, splice plate connectors, expansion joint assemblies, and fittings, showing accurately scaled components.
B. Product Data: Submit manufacturer's data on cable tray including, but not limited to, types, materials, finishes, rung spacings, inside load depths and fitting radii. For side rails and rungs, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).

1.5. QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of cable trays and fittings of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
B. Provide cable trays and accessories through one source from a single manufacturer.
C. NEMA Compliance: Comply with NEMA Standards Publication Number VE1, "Cable Tray Systems".
D. NEC Compliance: Comply with NEC, as applicable to construction and installation of cable tray and cable channel systems (Article 318, NEC).
E. UL Compliance: Provide products that are UL-classified and labeled in their final installed form.
F. NFPA Compliance: Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.

1.6. DELIVERY, STORAGE AND HANDLING

A. Deliver cable tray systems and components carefully to avoid breakage, denting and scoring finishes. Do not install damaged equipment.
B. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials should be unpacked and dried before storage.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

A. Wire Mesh Basket type cable tray systems:
    1. Subject to compliance with these specifications, wire mesh basket type cable tray systems shall be as manufactured by Eaton B-Line, Inc.; Mono-Systems, Inc, Chalfant or Legrand Cablofil.

B. Ladder type cable tray systems:
    1. Subject to compliance with these specifications, ladder type cable tray systems shall be as manufactured by Eaton B-Line, Inc.; Mono-Systems, Inc or Chalfant.

2.2. CABLE TRAY SECTIONS AND COMPONENTS

A. Typical Cable Tray Application (applicable unless noted otherwise on plans):
    1. Containing only low voltage cabling AND concealed above accessible ceilings, below raised access floors or within telecommunications rooms: Wire mesh basket type with:
        a. Useable Loading Depth: 4”.
        b. Minimum Load Rating: NEMA 12C.
        c. Material: Black powder coat painted steel.
        d. Width(s): as shown on plans.
    2. All other applications: Ladder-type with:
        a. Rung Spacing:9” o.c.
        b. Useable Loading Depth: 4”.
        c. Minimum Load Rating: NEMA 12C.
        d. Material: Aluminum.
        e. Width(s): as shown on plans.

B. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with clamp assemblies, connector/splice plates, splice bars, bolts, nuts and washers for connecting units as required. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards.

C. Cable tray construction:
   1. Wire Mesh Basket type cable tray systems:
      a. All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.
      b. Wire mesh basket type cable tray shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. Minimum wire diameter shall be 5mm (4.5mm for stainless steel). All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.
      c. All fittings shall be factory-built or shall be formed from straight sections in accordance with manufacturer's instructions to maintain the UL Classification of the system.
   2. Ladder type cable tray systems:
      a. Two longitudinal members (side rails) fabricated as I-beams with transverse members (rungs) welded (for metallic construction) or mechanically-fastened and adhesively bonded (for fiberglass construction) to the side rails.

D. Materials and Finish: Specific material and finish types for each tray type (as specified elsewhere) shall comply with the following general requirements:
   1. Aluminum: All sections and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
   2. Pre-galvanized Steel: All sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.
   3. Hot-dip Galvanized Steel: All sections and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter and ASTMA510, Grade 1008 for wire mesh basket type, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray. All hot-dip galvanized after fabrication steel cable trays must be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so can cause damage to cables and/or injury to installers.
   4. Stainless Steel: All sections, accessories and fitting side rails and rungs shall be made of AISI Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire. Wire mesh basket type shall meet minimum mechanical properties of ASTM A580.
   5. Black Powder Coated steel: All sections/components shall be powder coated black with an average paint thickness of 1.2mils (30microns) to 3.0mils (75microns).
   6. Fiberglass: All sections/components shall be pultraded from non-conductive glass fiber reinforced polyester or vinyl ester resin. Pultraded shapes shall be constructed with a surface veil to insure a resin-rich surface and UV resistance,

and shall meet ASTM E-84, Class 1 flame rating and self-extinguishing requirements of ASTM D-635.

E. Accessories and Supports:
   1. General:
      a. Cable Tray Supports: Shall be placed so that the support spans do not exceed maximum spans allowed to achieve the specified cable tray load ratings.
      b. Center hung supports shall be manufactured of 12 gauge, 1-5/8 inch by 1-5/8 inch B-Line B22 steel strut with a pipe welded at the middle of the support to provide eccentric loading stability. Support shall withstand 700 pounds in a 60 percent vs. 40 percent eccentric loading condition with a safety factor of 3.
      c. Accessories - special accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, conduit-to-tray adapters, etc.
   2. Wire Mesh Basket type cable tray systems:
      a. Barrier Strips: Shall be provided where specified on plans or where cables/conductors of varying voltage classes are installed within the same tray (per NEC requirements), shall be manufactured by the tray system supplier and shall be fastened into the tray as directed by the tray system supplier.
   3. Ladder type cable tray systems:
      a. Splice plates shall be the bolted type for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
      b. Barrier Strips: Shall be placed along full length of all tray sections, shall be manufactured by the tray system supplier and shall be fastened into the tray with self-drilling screws.

PART 3 - EXECUTION

3.1. INSTALLATION

A. General:
   1. Installers of wire mesh basket type cable tray systems shall be certified by the supplier of the cable tray system.
   2. Install cable trays as indicated: Installation shall be in accordance with:
      a. Equipment manufacturer's instructions.
      b. Recognized industry practices.
      c. NEC (Article 392 and others).
      d. Applicable portions of NFPA 70B.
      e. NEMA-VE2.
   3. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the owner or owner’s representative.
   4. Coordinate cable tray installation with other work as necessary to properly interface installation of cable tray with other work.

B. Cabling:
    1. All cabling/conductors routed in cable tray shall be rated for cable tray application.
    2. Cabling/conductors of varying voltage classes installed within common trays shall be separated by barrier strips per NEC requirements.
    3. Cable/conductor securing:
        a. Cables/conductors shall be secured to the transverse elements of the associated trays at the following minimum intervals:
            1) Seismic, high-shock or vibration prone areas (such as mechanical rooms, process areas, etc.):
                (a) All cables/conductors: 24".
            2) Non-horizontal cable tray sections:
                (a) All cables/conductors: 36".
            3) Horizontal cable tray sections:
                (a) All power cables/conductors: 36"
                (b) Control, instrumentation and network cables in cable trays in exposed areas: 36"
                (c) Control, instrumentation and network cables in cable trays in concealed interior areas (such as above lay-in ceilings): No cable ties required.
        b. All cable ties used to secure cables to trays in interior areas shall be plenum-rated plastic. Cable ties used in interior exposed areas (subject to light) in interior areas shall be sunlight/UV-resistant. Cable ties used in exterior environments shall be of non-magnetic stainless steel construction.
    4. Cable/conductor arrangement:
        a. Provide separation between power cables/conductors within cable trays for proper heat dissipation (and conductor ampacity ratings) per NEC requirements.

C. Bonding:
    1. Ground and bond metal cable tray in accordance with NEC Articles 392, 250.96 and 250.102.
        a. Provide continuity between all metal cable tray components.
        b. Make connections to tray using mechanical, compression or exothermic connectors.
    2. Cable trays shall be properly bonded with grounding harnesses or other necessary equipment as required to all metal conduits terminating into the cable trays and between cable tray sections.

D. Location/Routing:
    1. Location of cable tray shown on plans is for general routing only. Field coordinate exact cable tray locations/routing with all piping, equipment, ductwork, structure, lighting, etc. & other trades prior to ordering cable tray. Provide vertical & horizontal bends as required, maintaining proper clearance around cable trays.
    2. Coordinate cable tray with all other work as necessary to properly integrate installation of cable tray work with other work. Any potential conflicts between locations of cable trays and locations of other items shall promptly be brought to the attention of the engineer prior to installation.
    3. Provide a minimum of 6" clearance on top of cable trays and 3" clearance on bottom and sides of cable trays to permit access for installing and maintaining cables unless specifically approved or directed otherwise by engineer.

E. Support:
   1. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions.
   2. Trapeze hangers and center-hung supports shall be supported by 1/2 inch (minimum) diameter all-thread rods unless noted otherwise. Trapeze hangers supporting wire mesh basket type cable trays 12” wide or less may be supported by 3/8 inch (minimum) diameter all-thread rods.

F. Penetrations:
   1. Where cable trays pathways pass through walls, floors, ceilings or other similar partitions that are fire-rated, smoke-rated, designed to prevent water entry, designed to limit sound transmission, or designed to limit air passage (for environmental or conditioning purposes), cable trays themselves shall not penetrate the partition but shall be terminated on either side of the partition. The partition shall be penetrated with conduit sleeves sealed with suitable fire caulk or other approved material, per specific instructions of the caulk supplier to maintain partition/etc. ratings (such as fire or smoke ratings), after installation of all cabling. Bonding jumpers shall be provided through sleeves to ensure electrical continuity of cable tray system. Interior cross-sectional area of the conduit sleeves shall match or exceed the interior cross-sectional area of the associated cable tray(s).
   2. Contractor shall verify arrangement, sizes and locations of all penetrations through load-bearing walls, floors or other structural items with structural engineer. Contractor shall submit sketch of proposed sleeve locations to structural engineer for review prior to rough-in.

G. Marking:
   1. Cable trays containing conductors rated over 600 volts shall have a permanent, legible warning notices installed per NEC 392 requirements.

3.2. TESTING

A. Test cable trays to ensure electrical continuity of bonding and grounding connections. See NFPA 70B, Chapter 18, for testing and test methods.
B. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1; including test reports verifying rung load capacity in accordance with NEMA VE-1 Section 5.4.

END OF SECTION 26 05 36

SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1. DESCRIPTION

A. Wire and cable identification.
B. Pullbox & Junction Box Identification
C. Electrical distribution & utilization equipment identification.
D. Emergency and Standby Power receptacle identification.
E. Instrument and control device identification.
F. Raceway identification.

PART 2 - PRODUCTS

2.1. WIRE AND CABLE IDENTIFICATION

A. Intermediate Locations:
   1. Wires and cable labels shall be white, thermal transfer, halogen-free, flame-retardant marker plates (sized to accommodate three lines of text) permanently affixed to the associated cable with UV-resistant plastic wire ties. Labels shall be Panduit #M200X/300X series or equal.

B. Circuit/Cable Termination Locations:
   1. Wires and cable labels shall be non-ferrous identifying tags or pressure sensitive labels unless noted otherwise.

2.2. ELECTRICAL DISTRIBUTION & UTILIZATION EQUIPMENT IDENTIFICATION

A. Labels on electrical distribution & utilization equipment shall be black-on-white engraved Bakelite nameplates permanently affixed to the equipment with rivets or silicone adhesive unless noted otherwise.

2.3. EMERGENCY AND STANDBY POWER RECEPTACLE IDENTIFICATION

A. Receptacles fed from emergency or standby power sources (such as emergency generators) shall be provided with factory-marked engraved coverplates as follows:
   1. Emergency System source: Red engraved lettering to read “EMERGENCY”.
   2. Legally-Required or Optional Standby Generator source:
      a. If only part of facility is fed with generator backup: Black engraved lettering to read “FED FROM GENERATOR”.
      b. If entire facility is fed with generator backup: No “….GENERATOR…” label required.

2.4. INSTRUMENT AND CONTROL DEVICE IDENTIFICATION

A. Instruments and control device labels shall be black-on-white engraved Bakelite nameplates permanently affixed to the equipment or the adjacent, visible mounting surface with silicone adhesive or stainless steel wire ties.

2.5. RACEWAY IDENTIFICATION

A. Raceway labels shall be white thermal transfer marker plates permanently affixed to the associated raceway with stainless steel wire ties, with two wire ties (one on either end of marker plate to provide a flush installation) where possible. Labels shall be Panduit #M300X series or equal.

PART 3 - EXECUTION

3.1. GENERAL

A. Any proposed deviation in identification methods and materials from those described herein shall be submitted to Engineer for review and comment prior to installation.
B. Contractor shall provide all labeling or identification required by applicable local, state and national codes. These specifications do not intend to itemize all code-required labeling or identification requirements.
C. All labels/identification shall be positioned such as to be readable from the normal perspective without adjusting wiring/cables/labels. For example, labels/identification of wires/cables within cable trays shall be positioned to point towards the viewer (typically downward for overhead cable trays, or upward for cable trays within trenches).
D. All labels/identification (except for handwritten labels on concealed pullbox/junction box covers as noted below) shall be typewritten/printed/engraved in a neat, workmanlike, permanent, legible, consistent and meaningful manner. Labels shall not be handwritten unless specific approval is granted by engineer.

3.2. WIRE AND CABLE IDENTIFICATION

A. General:
    1. Where cabling is exposed (such as within cable trays), provide two wire ties per cable (one on either end of marker plate to provide a flush installation). Where cabling is concealed (such as within pullboxes/wireways), one wire tie per cable will be acceptable.

B. Intermediate Locations:
    1. Thermal transfer labels shall be securely fastened to all wiring and cabling in the following locations:
        a. Wireways
        b. Pullboxes/Junction boxes larger than 4-11/16”
        c. Pullboxes/Junction boxes through 4-11/16” where wires and cables are not easily identifiable via the color coding and box labeling
        d. Vaults & Manholes
        e. Approximately every 50 feet within cable trays (especially at locations where cables exit or diverge). Labels within cable trays shall be grouped (rather than being pre-labeled on cables and pulled into cable trays).
        f. Other similar intermediate locations.
    2. Labels shall be stamped or printed with the following data so that the feeder or cable can be readily identified and traced:
        a. From where the circuit originates (including panel designation and circuit number):
            1) Ex: “FROM: PP-A CIR. 3 (IN MAIN ELEC ROOM)”
        b. To where the circuit extends (using the common name of the equipment):
            1) Ex: “TO: RTU-6 (ON ROOF)”
        c. The purpose of the circuit:
            1) Ex: “POWER”

d. The set number (If parallel power feeds are used).
1) Ex: “SET NO. 3 OF 4”

C. Circuit/Cable Termination Locations:
1. Where multiple termination points exist within a circuit origination point (panelboard, switchboard, MCC, starter, etc.) or other similar circuit endpoint (control panel, etc.), labels shall be securely fastened to all ungrounded and neutral conductors to clearly identify the terminal and/or circuit number associated with each conductor. For example, within lighting panels, each phase and neutral conductor shall be labeled near the terminals at a clearly visible location with the associated circuit number(s), so that if all conductors were unterminated, the labels would clearly indicate which conductor was associated with each circuit.

D. Refer to Specification Section 26 05 19 for all color-coding requirements of wires and cables.

3.3. PULLBOX & JUNCTION BOX IDENTIFICATION

A. Concealed pullboxes/junction boxes:
1. Front surface of all pullbox/junction box covers in concealed areas (such as above lay-in ceilings) or within mechanical/electrical rooms (and other similar areas where appearance of boxes is not an issue) shall be neatly marked with the ID of circuits/cables contained with permanent black marker on cover of box (Ex: “RP-1A Cir. 1, 2 & 3”). Additionally, front surface of box shall be painted red where box contains fire alarm system cabling.

B. Exposed pullboxes/junction boxes:
1. Interior surface of all pullbox/junction box covers in exposed areas shall be labeled “Power”, “Telecommunications”, “Fire Alarm” or with other similar general text neatly with permanent black marker to indicate function of box. Circuit/cable labeling within box (see above) shall identify specific cables contained. Additionally, interior surface of cover shall be painted red where box contains fire alarm system cabling.

C. Where pullboxes/junction boxes are named on contract documents (Ex:”PULLBOX #3”), an engraved nameplate shall be installed on the front surface of the box to identify the name.

3.4. ELECTRICAL DISTRIBUTION & UTILIZATION EQUIPMENT IDENTIFICATION

A. General:
1. All new and existing equipment modified by this project shall include arc-flash warning labels in accordance with NEC article 110.16.

B. All Panels, Motor Control Centers, Switchboards, Switchgear, Transformers, Etc.:
1. Engraved nameplates identifying name of equipment, nominal voltage and phase of the equipment and where the equipment is fed from shall be installed on front surface of all panels, motor control centers, switchboards, switchgear, transformers, etc.:
a. Ex: First Line: “NAME: RP-A”, Second Line: “120/208V-3Ø-4W”, Third Line: “FED FROM: PP-A CIR. 4 (IN MAIN ELEC ROOM)”

2. Refer to Panelboard Specification Sections for additional labeling requirements (circuit directory cards, permanent circuit labels, permanent circuit numbers, etc.) required inside panelboards.

C. Safety/Disconnect Switches and Utilization Equipment (HVAC Equipment, Pumps, Powered Valves, Control Panels, Starters, Etc.)::
   1. Engraved nameplates identifying equipment being fed and where the equipment is fed from shall be installed on front surface of all disconnect switches (including both visible blade type switches and toggle-type switches) and on utilization equipment (where not clearly identified by immediately adjacent local disconnect switch):
      a. Ex: First Line: “RTU-6”, Second Line: “FED FROM: PP-A CIR. 5”
   2. Where safety/disconnect switches are installed on the load side of variable frequency drives, the safety/disconnect switch shall be furnished with an additional engraved nameplate to read: “WARNING: TURN OFF VFD PRIOR TO OPENING THIS SWITCH”.
   3. Safety/Disconnect switches feeding equipment that is fed from multiple sources (such as motors with integral overtemperature contacts that are monitored via a control system) and Utilization Equipment fed from multiple sources shall be furnished with an additional BLACK-ON-YELLOW engraved nameplate to read: “WARNING: ASSOCIATED EQUIPMENT FED FROM MULTIPLE SOURCES – DISCONNECT ALL SOURCES PRIOR TO OPENING COVER”.

D. Emergency Systems:
   1. A sign shall be placed at the service entrance equipment (and at any remote shunt trip operators, or similar, for service equipment) indicating the type and location of on-site emergency power sources (such as generators, central battery systems, etc.) per NEC requirements.
   2. All boxes and enclosures (including transfer switches, generators, power panels, junction boxes, pullboxes, etc.) dedicated for emergency circuits shall be permanently marked with white-on-red engraved nameplates so they will be readily identified as a component of an emergency circuit or system.

E. Services:
   1. All Service Equipment:
      a. Engraved nameplates identifying maximum available fault current, including date the fault current calculation was performed, in accordance with NEC article 110.24.
         1) Ex: First Line: “AVAILABLE FAULT CURRENT: 16,154 AMPS”, Second Line: “DATE CALCULATED: JULY 8, 2013”
      b. All service entrance equipment shall be clearly labeled as being service entrance rated.
   2. Where a building or structure is supplied by more than one service (or any combination of branch circuits, feeders and services), a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders & branch circuits supplying that building or structure and the area served by each, per NEC requirements.

F. Generators:
   1. Generators shall be labeled with engraved nameplates identifying name of equipment.

3.5. EMERGENCY AND STANDBY POWER RECEPTACLE IDENTIFICATION

A. Receptacles fed from emergency or standby power sources (such as emergency generators) shall be provided with factory-marked engraved coverplates as described above.

3.6. INSTRUMENT AND CONTROL DEVICE IDENTIFICATION

A. New Instruments and control devices (whether furnished by contractor or not) shall be labeled with black-on-white engraved nameplates permanently affixed to the equipment or to the adjacent, readily-visible mounting surface with silicone adhesive or stainless steel wire ties.
   1. Instruments and process control devices (float switches, etc.) shall be labeled with instrument name and, where available, instrument ID number.
   2. Pushbutton stations shall be labeled with equipment being controlled. Labels shall be installed on front surface (or adjacent mounting surface) of all pushbutton stations.
   3. Thermostats and other similar HVAC control devices installed in process areas shall be labeled with equipment being controlled. Labels shall be installed on front surface (or adjacent mounting surface) of all thermostats and other similar HVAC control devices.

3.7. RACEWAY IDENTIFICATION

A. Each exposed raceway shall be labeled at the point where it becomes concealed, such as where it enters a concrete floor slab, a concrete wall, the ground, etc.
B. Each raceway entering in-grade or on-grade pullboxes/junction boxes, where the conduits are only visible inside the box, shall be labeled within the box at the point where the raceway becomes concealed.
C. Raceway nameplates shall identify:
   1. The location of the other end of the raceway (“TO MCC-1” or similar). If the other end of the raceway is at an intermediate, named pullbox (“INSTRUMENTATION PULLBOX #4” or similar), that pullbox name shall be labeled rather than the endpoint of the circuitry.

3.8. OTHER IDENTIFICATION

A. Factory-engraved coverplates identifying functions of light switches and other similar devices shall be installed where so required by plans/specifications.

END OF SECTION 26 05 53

SECTION 26 05 73 - POWER DISTRIBUTION SYSTEM ELECTRICAL STUDIES

PART 1 - GENERAL

1.1. SCOPE OF WORK

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:
   1. Power Distribution System Electrical Studies.

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS

A. Short Circuit Studies, Protective Devices Evaluation Studies, Protective Device Coordination Studies and Arc Flash Hazard Studies shall be performed by the same entity, which shall be a Professional Engineer registered in the state where the equipment will be installed. The studies shall be per the requirements set forth in the latest edition of NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D.
B. The studies shall be submitted to the Engineer prior to shipment of any electrical distribution equipment.
C. The studies shall include all portions of all electrical systems affected by the project (including the existing service and all existing power distribution systems/equipment) from the utility services to any existing equipment at the facility (including all existing equipment fed from the same service point as any new equipment) and to all new equipment installed under this contract. All induction motors 50 HP or below and fed from the same bus may be grouped together. All induction motors greater than 50 HP shall be included individually with associated starters and feeder impedance. See individual study sections below for additional scope requirements.
D. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) or EasyPower software program.
E. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
F. The contractor shall be responsible for collecting data on any existing or proposed electrical equipment, devices, conductors, etc. as required to prepare the study, and shall supply pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the studies to be completed prior to shipment of equipment.
G. The Power Distribution System Electrical Studies shall be performed by Square 'D' or Cutler Hammer; or a third-party vendor if specifically approved by the engineer prior to preparation of the studies.
H. The proposed vendor shall have completed a minimum of five (5) equivalent Arc-Flash Hazard Studies in the past three (3) years.

2.2. SHORT CIRCUIT STUDY

A. The Short Circuit Study shall be performed with aid of a computer program. The study input data shall include the power company’s short circuit contribution, resistance and reactive components of the branch impedances, X/R ratios, base quantities selected,

and other source impedances.

B. Short circuit momentary duty values and interrupting duty shall be calculated on each individual basis with the assumption that there is a three-phase bolted short circuit at the respective switchgear bus, switchboard, low voltage motor control center, distribution panelboard, and other significant locations throughout the system.

C. The short circuit tabulation shall include symmetrical and asymmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contributions from each connected branch, including motor back EMF current contributions shall be listed with its respective X/R ratio.

2.3. PROTECTIVE DEVICE EVALUATION STUDY

A. The Protective Device Evaluation Study shall be performed to determine the adequacy of circuit breakers, switches, transfer switches, and fuses by tabulating and comparing the short circuit rating of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied.

B. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the Engineer's attention.

2.4. PROTECTIVE DEVICE COORDINATION STUDY

A. The Protective Device Coordination Study shall be performed to provide the necessary calculation and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. The objective of the study is to obtain optimum protective and coordination performance from these devices.

B. The coordination study shall show the best coordination attainable for all breakers down through the largest breaker at each piece of distribution equipment. Coordination study shall demonstrate selective coordination where required by applicable codes or contract documents.

C. Phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices. Where ground fault protection is used, coordination of the ground fault protection with the first downstream overcurrent phase protection device shall be demonstrated.

D. All applicable relay settings for the proposed paralleling switchgear system and the associated generators shall be determined by the preparer of this study. Coordinate with paralleling switchgear supplier to determine all relay setting requirements.

E. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves be maintained.

2.5. ARC-FLASH HAZARD STUDY

A. The Arc-Flash Hazard Study shall be performed with the aid of computer software intended for this purpose in order to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

B. The Arc-Flash Hazard Study shall be performed in conjunction with a short-circuit Study and a time-current coordination Study.

C. The Arc-Flash Hazard Study shall be performed for the following equipment:
   1. All Distribution Equipment – This includes but is not limited to the following:
      a. Switchgear

b. Switchboards
c. Motor Control Center
d. All Lighting and Power Panelboards
e. Fused Disconnect Switches rated greater than 100A

2. Separately enclosed devices fed from protection device rated greater than100A - This includes but is not limited to the following:
   a. Control Panels
   b. VFD's
   c. RVSS

D. A generic Arc-Flash label shall be applied to other electrical equipment that has not been included in the study. This includes but is not limited to the following equipment:
   1. Non-fused Disconnect Switches
   2. Fused Disconnect Switches rated 100A or less
   3. Transformers
   4. Control Panels, VFD's, RVSS, etc. rated 100A or less

E. Where a main protective device is provided, the study shall be performed on the line side and load side of the main. The worst-case result shall be used for the study result and label.

F. The Study shall be performed under worst-case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

G. Where incident energies are calculated to fall within the high marginal region of a given Hazard/Risk Category Level, the Hazard/Risk Category Level shall be increased one level.

H. The Arc-Flash Hazard Study shall be performed in compliance with the latest IEEE Standard 1584, the IEEE Guide for Performing Arc-Flash Calculations. Where IEEE 1584 does not have a method for performing the required arc-flash calculations (such as for single phase equipment), calculations shall be performed and system shall be modeled using modules/methods as recommended by the arc flash software supplier (for example, using SKM Unbalanced/Single Phase Studies module for modeling single phase systems).

I. Equipment labels to identify AFIE and appropriate Hazard/Risk Category in compliance with NFPA 70E and ANSI Z535.4 (latest version of these requirements) shall be provided to the Electrical Contractor. The Electrical Contractor shall affix the labels to the distribution equipment devices as directed by the equipment manufacturer. These labels shall, at a minimum, include the following:
   1. WARNING label.
   2. Hazard/Risk Category.
   3. Arc Flash Boundary Distance.
   4. Incident Energy (in cal/cm2) at Working Distance.
   5. Shock Hazard Voltage.
   6. Limited Approach Boundary Distance.
   7. Restricted Approach Boundary Distance.
   8. Prohibited Approach Boundary Distance.
   9. Equipment Name.
   10. Name of Firm who prepared the Study.
   11. Project Number of the Firm who prepared the Study.
   12. Date that the Study was prepared.
   13. Method for calculating analysis data.

14. Statement to read: “Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidate this label” (or equivalent).

PART 3 - EXECUTION

3.1. SUBMITTAL REQUIREMENTS

A. The results of the studies shall be summarized in a final report. The report shall include the following sections:
   1. General:
      a. Description, purpose, basis and scope of the studies
      b. Single line diagram of the portion of the power system which is included within the scope of the work. The single line diagram shall fit on one sheet of paper (size as required) unless approved otherwise by engineer. The following information shall be shown on the single line diagram:
         1) Device Name
         2) Branch Fault Currents with directional indicators
         3) General Location (for busses only)
         4) Other basic component information such as cable type, cable length, breaker rating, buss short circuit rating, transformer voltages, transformer size, fuse size, etc..
   2. Short Circuit Study:
      a. Tabulation of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding same.
   3. Protective Device Evaluation/Coordination Study:
      a. Protective devices time versus current coordination curves**,** tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
      b. Fault current calculations including definitions of terms and a guide for interpretation of computer printout.
      c. Documentation from utility company on their letterhead showing their anticipated values of available short circuit currents X/R ratios and protective devices with which the power distribution system will coordinate.
      d. Time-current characteristics of the respective protective devices shall be plotted on log-log paper. Plots shall be printed in color with a dedicated color and pattern for each curve for clear identification.
      e. Plots shall include complete titles, respective single line diagrams and legends, and associated power company’s relay or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breakers trip curves and fuses.
      f. The coordination plots shall indicate the type of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents.
      g. The coordination plots for phase and ground protective devices shall be provided on a system basis.
      h. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.
   4. Arc-Flash Hazard Study:

a. Tabulation of device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
b. Recommendations for reducing AFIE levels and enhancing worker safety.

B. Furnish all labor, materials, calculations, electrical equipment, technical data and incidentals required to provide a complete short circuit study, coordination study and arc flash hazard study of protective devices, busses, etc. from the utility service to any existing equipment at the facility and all new equipment installed under this contract.
C. The study shall comply with the following applicable provisions and recommendations of the latest revisions of the following: ANSI C37.5, IEEE Standard No. 399, and IEEE Standard No. 141.
D. Submit calculations and results of the short circuit, protective device evaluation and coordination and arc flash hazard studies prior to submitting shop drawings for new equipment. Contractor shall verify that all proposed equipment is properly rated per the short circuit and protective device evaluation portions of the study prior to releasing equipment for manufacturing.
E. Submit a copy of a sample typical arc flash label layout (meeting requirements outlined above) that will be used for the project.
F. Submit final electronic copies of all SKM program files/models/input data/etc. used to perform the study to the owner with final close-out documents. These files shall be complete as required to allow future users to recreate the study.

3.2. INSTALLATION

A. Contractor shall adjust all breaker settings as recommended by the coordination study prior to energizing equipment.
B. Contractor shall affix arc flash hazard notification labels (as determined by the results of this study) to each piece of distribution equipment prior to energization of equipment. A generic arc-flash warning label shall be affixed to any electrical equipment not included in the analysis as outlined above.
C. Where short circuit rating of equipment is dependent on setting of upstream overcurrent device, provide and install label for equipment indicating the required settings of the associated device.

END OF SECTION 26 05 73

SECTION 26 22 00 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1. GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:
   1. Dry Type Transformers

1.2. GENERAL REQUIREMENTS

A. Voltage for 3 phase units shall be 480V to 120/208V, three phase, four wire unless shown otherwise. Voltage of single phase units shall be 480V to 120/240V single phase, three wire unless shown otherwise.
B. Where isolation transformer is indicated on drawings, furnish K-13 rated transformer with dual-faraday electrostatic shield.
C.

PART 2 - PRODUCTS

2.1. INSULATION

A. Transformers shall be ventilated with insulation to withstand a minimum of 150 degree Celsius temperature rise (Class 220 insulation) unless specifically shown otherwise on the drawings.

2.2. ENERGY EFFICIENCY

A. Transformers shall comply with the latest applicable DOE energy efficiency requirements and latest edition of NEMA standard TP-1 and shall be labeled for the EPA Energy Star Program.

2.3. SOUND RATING

A. Sound level design may not exceed the following:

	KVA	DESIGN SOUND LEVEL
2.	0-45	40 db
3.	46-112.5	44 db
4.	113-150	47 db
5.	151-300	49 db
6.	301-750	58 db

B. Sound levels shall be determined in accordance with NEMA and ASA Standards. Core and coils shall be mounted on vibration isolator pads.

2.4. ENCLOSURES

A. Transformers mounted in dry, interior locations shall be furnished with NEMA 1 enclosures unless shown otherwise.
B. Transformers mounted outdoors or in wet locations shall be furnished with NEMA 3R

enclosures with drip shields unless shown otherwise.

C. Transformers installed inside motor control centers or other similarly enclosed equipment may be “open” units not requiring additional enclosures.

2.5. CLEARANCE REQUIREMENTS

A. Transformer construction/efficiency/ventilation shall allow 3” (or less) clearance from rear and sides.

2.6. TAPS

A. All units shall be equipped with a minimum of two (2) 2 ½% taps above nominal (FCAN) and a minimum of four (4) 2 ½% taps below nominal (FCBN) as required to allow adjustment of the turns ratio of the transformer to account for site voltage adjustments.

2.7. LUGS

A. Lugs shall be AL/CU compression type suitable for the quantities and sizes of conductors required.

2.8. MANUFACTURER

A. Transformers shall be Square 'D' or Cutler Hammer.

PART 3 - EXECUTION

3.1. GENERAL

A. Minimum clearances shall be provided on all sides of transformers per manufacturer’s and code requirements.

B. Where site voltages so require, transformer taps shall be adjusted to maintain nominal voltage on secondary side of transformer. Adjustment of dry-type transformer taps shall not be made until all upstream voltage adjustments (such as voltage tap adjustments at service transformers) are finalized.

C. Refer to Specification Section 26 05 26 for transformer grounding requirements.

D. Refer to Specification Section 26 05 53 for transformer identification requirements.

3.2. MOUNTING

A. Transformers shall be mounted as indicated on plans. No units shall be wall mounted unless shown or directed otherwise.

B. Floor mounted transformers:

1. Shall be installed on a minimum of four (4) double-deflection neoprene vibration isolators (by Amber/Booth, Korfund Dynamics or Mason Industries - size as required – with seismic restraint capability ratings as required by the associated seismic zone).
2. Shall be installed on four-inch thick concrete pads unless specifically shown otherwise. Pad shall have beveled edges.

C. Suspended transformers:

1. Shall be trapeze-mounted on unistrut frame supported by a minimum of four steel rods and shall be mounted as high as possible or at height directed (transformers

shall not be mounted above lay-in ceilings or in areas with restricted ventilation). Shall be installed using a minimum of four (4) double-deflection neoprene vibration isolators (by Amber/Booth, Korfund Dynamics or Mason Industries - size as required – with seismic restraint capability ratings as required by the associated seismic zone).

2. Contractor shall supply extra supports as may be required due to size and weight.
3. Additional seismic bracing shall be provided for suspended transformers in seismic zones as required to provide a fully code-compliant installation.

END OF SECTION 26 22 00

SECTION 26 23 00 - PARALLELING SWITCHGEAR

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Project drawings and contract documents requirements apply to this section.

1.2. SUMMARY

A. This section describes requirements for controls and switchgear for paralleling generator sets and distributing alternate source power. Equipment provided shall be new factory assembled paralleling equipment with dedicated purpose microprocessor-based controls designed for fast, reliable operation and including the functions described herein. Generator and Switchgear package shall be by the same Manufacturer.
B. Related sections of the project specifications include:
   1. Section 26 32 13 - GENERATOR SETS

1.3. DEFINITIONS

A. ATS: Automatic Transfer Switch
B. GFP: Ground Fault Protection.
C. HMI: Human-Machine Interface
D. PLC: Programmable Logic Controller. A device with associated accessory components that is designed to accept programmable inputs and provide completely field-programmable logically controlled outputs.
E. Manufacturer: The entity that maintains engineering design control for the equipment provided, provides service and maintenance documentation, provides service direction, and provides warranty support.
F. Supplier: The entity that provides manufacturer-authorized local sales and service support for the manufacturer’s equipment.

1.4. SUBMITTALS

A. Product Data: Provide the noted technical data for the controls, switchgear, and transfer equipment described in this section. Materials required include:
   1. Technical data fully describing the critical design features of the equipment proposed, and substantiating compliance to the requirements of this specification. This material shall include 3rd party certifications and listing details for all equipment provided, including seismic certifications described herein.
   2. Data shall include a complete description of the features and function of the proposed equipment, described on the manufacturer’s published literature or manufacturer’s letterhead with a manufacturer’s employee signature validating its accuracy.
   3. Include a listing of all setting ranges and factory default settings.

B. Include a detailed sequence of operation for the specific equipment provided.
C. Shop Drawings: For each control enclosure, switchgear section, or independent piece of equipment provide:
   1. Elevation and other Drawings: Describing physical dimensions, weights, mounting provisions and requirements, mechanical and wiring access points.

2. Wiring Diagrams: Interconnecting wiring details including recommended control conduit configurations.
3. Submit names, qualifications, and locations of individuals who will service and support the equipment.

D. Source Quality Control Test Reports: Provide sample factory test report plan for integrated generator controls and paralleling system.

1.5. QUALITY ASSURANCE

A. Testing Agency Qualifications
B. The paralleling equipment manufacturer shall be certified to ISO 9001 International Quality Standard
C. Source Limitations: The paralleling switchgear shall be designed, manufactured, and warranted by the generator set manufacturer to provide a single source of responsibility for all the products provided. Warranty documents shall be provided verifying compliance to this requirement. Supplier shall directly employ service technicians specifically trained and qualified on the diagnosis and repair of engines, alternators, power transfer equipment, and paralleling equipment. The technicians shall be trained in the installation and commissioning of complex generator systems, including line voltage generator paralleling equipment. Switchgear manufacturer shall have more than (15) years experience to ensure quality. Documentation for similar projects shall be provided upon request.
D. The paralleling system, including generator sets and paralleling equipment, shall be serviced by a single local service organization that is trained and factory certified in both generator set and paralleling equipment service. The technicians serving the site shall be specifically trained and certified by the manufacturer in the diagnosis and repair of the synchronizing, paralleling, and load sharing equipment provided. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
E. The manufacturer shall maintain model and serial number records for the paralleling equipment for at least 20 years.
F. Equipment provided shall conform to the requirements of the following codes and standards to the extent that they are applicable:
    1. UL891 – Switchboards and Controls. Control equipment provided in switchboard enclosures shall be listed and labeled under this standard.
    2. UL 489 – Molded Case Circuit Breakers
    3. EN55011, Class B Radiated Emissions
    4. EN55011, Class B Conducted Emissions
    5. EN60947-6-1 Standard for Low-voltage switchgear IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991
    6. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
    7. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
    8. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
    9. IEC 1000-4-6 Conducted Field Immunity
    10. IEC 1000-4-11 Voltage Dip Immunity
    11. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
    12. NFPA110 – Emergency and Standby Power Systems. All equipment provided shall meet all requirements for Level 1 systems.

13. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

1.6. DELIVERY, STORAGE AND HANDLING

A. Deliver paralleling system equipment in section sizes that can be moved past all obstructions in the physical site.
B. All paralleling equipment shall be stored indoors in a temperature controlled environment, in accordance with manufacturers temporary storage instructions. At a minimum, equipment shall be protected from moisture, dirt, and physical damage.
C. With written approval of the equipment manufacturer, equipment may be stored outdoors, as long as it is protected according to the manufacturer's instructions, including protection from condensation, rain, dust/dirt, and physical damage.

1.7. EXTRA MATERIALS.

A. Provide additional items to support the paralleling system equipment, completely programmed and tested, packaged and labeled consistently with designations in system drawings.
   1. One set of fuses of each type used in the system
   2. Submit one racking handle(s) with equipment. A charging handle shall be furnished on each breaker mechanism.
   3. For all switchgear with circuit breakers in upper compartments, provide [one] circuit breaker lifting device - portable, floor-supported with a roller base.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Acceptable Manufacturers: The paralleling switchgear shall be provided by the generator supplier. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on microprocessor-based paralleling equipment manufactured by Cummins Power Generation. Digital Paralleling Equipment by other suppliers that meets the requirements of this specification is acceptable, if approved not less than 2 weeks before scheduled bid date. Proposals must include a line by line compliance statement based on this specification.

2.2. GENERATOR PARALLELING MONITOR AND CONTROL SYSTEM

A. Acceptable Manufacturers
   1. Cummins Power Generation (Equipment specifications for this project are based on microprocessor-based paralleling equipment manufactured by Cummins Power Generation).
   2. Caterpillar

B. Individual Generator Monitoring and Control Panel: Provide a paralleling control panel for each generator set in the emergency/standby power system. The paralleling control functions shall be integrated with the generator set control functions, and provided in a single, dedicated purpose microprocessor-based control designed and manufactured by the generator set manufacturer. Each paralleling control panel shall contain the functions as described in this section. No PLC-based control shall be used to provide

these functions. Each paralleling control shall be independent and autonomous, requiring no interaction with other controls for proper operation, except load sharing and paralleling breaker status functions. Failure of the system master control shall have no impact on the functions described in this section for the generator sets.

1. Operator Panel. Each paralleling control shall be provided with an operator panel to allow the operator to view the status and control operation of the specific generator set being paralleled. The operator panel shall be provided with the following features and capabilities.
    a. 1% or better accuracy generator set AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter, or other means shall be provided to allow viewing of voltage and amperes for each phase shall be provided. For 3-phase/4-wire systems the voltmeter shall indicate line to line and line to neutral conditions. Voltmeter, ammeter, frequency meter, kW meter and power factor meter shall have both analog and digital displays. Switches and/or other provisions shall be included to allow reading of bus voltage and frequency from this metering set.
    b. Synchronizer shall be an integral part of the multi-function digital generator set control. Independent synchronization swing panels are prohibited.
    c. Running Time Meter, Start Counter
    d. Generator Set Operator Panel: Panel shall provide manual and automatic functions for control of the generator set. Press the manual mode button to put the unit in manual mode if the operator does not press the Start button in 10 seconds, the control is put in the Off mode. Both manual and off modes prevent generator set from starting remotely or immediately shuts down the generator set if it is running. Press the auto mode button to put the unit in auto mode. The auto mode allows remote start, stop, breaker open, and breaker closed commands to be active. Generator controller must withstand voltage drops down to 8V DC upon engine starting.
    e. Breaker trip/close switch with breaker status indicating lamps. The switch shall be interlocked with the control system such that breaker closure is not possible unless the mode select switch is in the run position and the generator set is synchronized with the system bus.
    f. Control Reset push button switch with indicating lamp. Lamp shall flash to indicate that generator set is locked out due to a fault condition.
    g. Lamp test push button switch. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.
    h. The control panel shall be provided with a set of DC-powered lamps with a switch to allow viewing of all functions on the front panel when normal lighting systems are not available.
    i. Precision voltage and frequency raise lower function. The generator set frequency and voltage may be adjusted plus or minus 5% when the generator set is operating independently of the system bus. Voltage and frequency adjustments are integral to the generator set control, along with bus metering, breaker control switches, and manual paralleling controls for ease of use by the operator. The ability to make frequency and voltage adjustments shall be disabled when the paralleling breaker is closed. Voltage and frequency adjustments while the paralleling breaker is open shall not impact on the load sharing when the paralleling breaker is closed.
    j. Alarm and status indicating panel to indicate the following conditions (alarm horn shall be located on master control)

2. Internal Controls. The following internal control functions shall be provided for each generator set in the system.
    a. Electronic isochronous kW load sharing control to operate the engine governors during synchronizing and to provide isochronous load sharing when paralleled. The control system shall allow sharing of real kW load between all generator sets in the system to within 1% of equal levels, without introduction of frequency droop into the system. The control system shall include all equipment required for kW load sharing with an infinite bus. The infinite bus governing controls shall allow the generator set to synchronize to an infinite bus, parallel, and ramp up to a preset load level on the generator set. Additional controls shall be provided to cause the generator set to ramp up to a kW load level signaled by the system master control. The isochronous load sharing module and engine governor shall be a coordinated system of a single manufacturer.
    b. Load demand governing controls shall be provided to cause the generator set to ramp down to zero load when signaled to shut down in a load demand mode. On a signal to re-start, the load demand governing controls shall cause the generator set to synchronize to the system bus, close, and ramp up to it's proportional share of the total bus load. The ramp rate of the generator set shall be operator-adjustable.
    c. Electronic kVAR load sharing control to operate the alternator excitation system while the generator set is paralleled. The control system shall allow sharing of reactive load between all generator sets in the system to within 1% of equal levels, without introduction of voltage droop into the system. The control system shall include all equipment required for VAR load sharing with an infinite bus in either a constant VAR or constant power factor mode for future application flexibility. (Mode and adjustments selectable by the operator)
    d. Equipment shall be provided to monitor the generator set as it is starting, and verify that it has reached at least 90% of nominal voltage and frequency before closing to the bus. The equipment provided shall positively prevent out of phase paralleling if two or more engine generator sets reach operating conditions simultaneously by providing a lockout signal to disable breaker closure for generator set(s) in the system which have not been selected to be the first units to close to the bus. Controls to recognize the failure of the first breaker signaled to close, and allow system operation to proceed in spite of this failure shall also be provided (breaker failure alarm). Systems using dead bus relay schemes without a disable signal to positively prevent out of phase paralleling shall not be acceptable under this specification. System shall include an independent backup to automatically operate in the event that the primary system fails.
    e. Synchronizer to electronically adjust the engine governor to match the voltage, frequency and phase angle of the bus. Synchronizer shall maintain the engine generator voltage within 1% of bus voltage and phase angle within 15 electrical degrees of the bus for 0.5 seconds before circuit breaker closing. Each unit shall have its own synchronizer; systems using a switching scheme to utilize a single system synchronizer will not be approved. Synchronizers and systems which utilize a motor driven pot for control of AC voltage during the synchronizing process will not be accepted. The system shall be provided with a fail to synchronize time delay that is adjustable from 10-120 seconds. Control logic for fail to synchronize

function shall allow field adjustment of function for either alarm or shutdown of the generator set on failure condition.

f. Controls shall include a permissive relay function to assure that the generator set does not attempt to close out of phase with the bus, due to errant operation of the synchronizer.

g. Controls shall include a permissive (sync check) function, to be used with “generator synchronized” indicator during manual paralleling, to prevent accidental closure of the breaker with the generator set out of phase with the bus. Provisions to allow manual closure of the first generator set to a de-energized bus shall be included.

h. Controls shall be provided to verify generator set and bus phase rotation match prior to closing the paralleling breaker.

i. Electronic alternator overcurrent alarm and shutdown protection. This protection is required in addition to the overcurrent trip on the paralleling breaker, and shall sense current flow at the generator set output terminals. The overcurrent alarm shall be indicated when the load current on the generator set is more than 110% of rated current for more than 60 seconds. The overcurrent shutdown shall be matched to the thermal damage curve of the generator set, and shall not have an instantaneous function.

j. Electronic alternator short circuit protection. This protection is in addition to the overcurrent trip on the paralleling breaker. The short circuit shall occur when the load current on the generator set is more than 175% of rated current and an aggregate time/current calculation indicates that the system is approaching the thermal damage point of the alternator. The equipment used shall not have an instantaneous function and shall be selectively coordinated with the feeder circuit breakers. This protective function shall be provided by equipment that is UL-listed as a utility grade protective relay.

k. Provide overcurrent and short circuit protection for the conductors connecting the generator set to the paralleling switchgear. This protection may be integrated with alternator protection but must be positively coordinated to prevent tripping of the paralleling breaker prior to the operation of the alternator protective equipment.

l. Controls shall be provided to sense reverse VAR conditions on the alternator while paralleled to the system bus. Reverse VAR protection shall be set to operate as directed by the power company in coordination with the generator supplier’s requirements. A reactive capability curve shall be provided to allow proper setting of this protection. Reverse power, etc. protective relaying, etc. shall be provided / integrated into the paralleling switchgear as required to satisfy all requirements of the associated power company.

m. Generator set start contacts rated 10 amps at 32 VDC. A redundant network-based starting system shall also be provided.

n. Cooldown time delay, adjustable: 0-600 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for shutdown.

o. Start time delay, adjustable: 0-300 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for start.

p. Controls shall be provided to shut down generator set and initiate alarm when the generator set is at less than 85% of nominal voltage for more than 10 seconds, more than 110% of nominal voltage for more than 10 seconds.

When the control is set to operate as Inverse time, the unit will be more sensitive to voltage spikes and trip more rapidly.

q. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for reliable system operation, as described herein under “SYSTEM OPERATION".

C. Master Control System and Monitoring Equipment: Provide an independent system master control (located within the paralleling switchgear gear/lineup) to monitor and control the operation of the entire paralleling system.

1. Operator Panel. The master control panel shall be provided with at least a 15 Inch full color high resolution resistive touch Advantech HMI operator interface panel to allow the operator to view the status and control operation of system. The operator panel shall be provided with the following features and capabilities.

a. Main One Line Screen shall give a graphical display of the power system components directly controlled by the paralleling system. System status displays a combination of multi-color animation, messages and pop-up indicators.

b. System Control Screen shall provide the operator with the ability to:

1) Enable or disable load demand operation;
2) Initiate test (with or without load);
3) Control the shutdown sequence for the generator sets in the load demand mode;
4) Set the load demand time delays;
5) Set the load demand operation set points;
6) Display and modify the automatic load add and shed sequence.
7) Add in project specific features if required (customer specific modes of operation)

c. Load Control Screen shall allow the operator to monitor genset capacity, levels of load that have been added or shed.

1) Allow the operator to manually shed or add loads levels.
2) Display the name, status and priority of each load block (whether on or off).
3) Display total load, as a percentage of online generation capacity, displays on a bar graph in kW and amps.
4) Display actual system load.

d. Bus metering display shall include the following parameters for each bus segment:

1) Bus Line to Line voltage (all three phases simultaneously),
2) Bus Line to Neutral voltage (all three phases simultaneously),
3) Bus output current (all three phases simultaneously),
4) KW output of bus and as a percentage of rated KW,
5) KVA,
6) KVAR,
7) KW hours
8) KVAR hours
9) Bus line to line voltage (all three phases simultaneously) (graphical format),
10) Power Factor (graphical format), F
11) Bus output current (all three phases simultaneously) (graphical format),

e. KW output of bus, (graphical format) Frequency (graphical format).

1) Selector buttons shall be provided to allow the user to choose which bus to monitor.

f. Active Alarm Screen shall display the date, time, alarm description and acknowledged date and time for genset and system alarms (alarm horn shall be located on master control).

g. Historical Alarm Log Screen shall display the date, time, alarm description and acknowledged date and time for genset and system alarms (alarm horn shall be located on master control). These alarms should be stored and displayed in the master control for x days or x alarms.

h. Real Time Trending Screen should monitor and display four pens simultaneously. Display parameters should include voltage, current, power, and frequency for each bus. Selector buttons shall be provided to allow the user to choose which bus to monitor.

i. Historical Trending Screen The system shall include historical trending which collects, displays, and stores data. The historical data base shall be a FIFO file with storage capacity up to 26 days, or saved to a USB flash drive. Data will be saved in ".csv" file format. Each trend pen will have stop/pause/zoom features to allow the operator to magnify the trend, and also scroll back in time to view history. Historical Trend properties shall include: Refresh rate = on data change or every 2 seconds Buffering for extra data = 360 data points Continuous scrolling with pause and sliding time Time span on display = 8 hours (normal view) Time span on display = 2 hours (zoon view) USB data storage = 1 Year (with Minimum 1 Gig) Maximum and Minimum scale values = selectable by operator via touch screen Print screen function Required Trend pens required: Total KW Total KVAR Average Amps Average L-L Voltage

j. User Login Security shall consist of 3 levels of security: Guest, Operator, and Technician. Automatic logout feature will reset access to “Guest” after defined period of time

k. Event Log Screen shall be capable of logging all breaker operations, security level changes, and system status changes with a time and date stamp.

l. The plant test report function shall provide a record that System generator sets have been operated above 30% load for a particular duration. The report shall be enabled individually for each generator set in the system. The report duration shall be adjustable between 5 – 240 minutes. The control will store at least 12 reports per generator. The operator may select, view, and print any and all of the 12 available reports per generator set. Reports shall be available via the remote web interface or FTP site. Each report shall contain the following information: Generator Set Name, Generator Set Model, 3 Phase L-L Voltage, 3 Phase Amps, Frequency, Power Factor, % KW, KW, KVAR, KVA, Oil Pressure, Coolant Temperature, Battery Voltage, Engine Hours

m. All screens shall have detailed help content

n. Diagnostic screens shall display: Operator panel diagnostics, Communications processor diagnostics and Primary controller diagnostics

o. Modbus TCP/IP over Ethernet for SCADA Interface. Refer to Specification Section 26 29 00 (“Manufactured Control Panels”) for SCADA network connection requirements.

2. Internal Controls. The following internal control components or functions shall be provided for the master control:

a. Provide load demand control signals for each generator set provided, which operate when enabled to minimize fuel consumption during extended outages. The load demand can be enabled or disabled.
b. Load add and shed output contacts, rated 10 A at 250VAC/VDC. The priority level for each load shed contact set shall be field configurable through the master control operator panel.
c. The master functions shall include:
    1) Automatic and manual start/stop commands for generator sets as well as paralleling breaker control.
    2) System test with and without load initiated locally or remotely
    3) Extended paralleling function includes peak shave and base load and may be initiated locally or remotely
    4) Bus Overload function used to initiate load shed.

3. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for proper and reliable system operation.
4. Master control equipment shall contain a system of diagnostic LED's to assist in analyzing proper system function.

D. Construction

1. Manufacturer shall supply drawings that note dimensions, access requirements, and conduit entry details.
2. The master control system shall be listed and labeled under the requirements of UL891 including all covers, barriers, and supports. Individual control sections shall be isolated from each other by metal or insulating barriers.
3. All wiring shall be IEC UL891 listed 105 deg C, 600 volt rated and sized as required. Each wire, device or function shall be suitably identified by silk screen or similar permanent identification.
4. The framework and all other sheet metal components of the system shall be primed with a rust inhibiting primer, and finished with two coats of satin finish ANSI 61 gray enamel and must meet corrosion requirements of IEC 61439
5. All door mounted control components shall be industrial type oil tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.
6. AC control circuits in the switchboard shall be protected with properly sized fuses or circuit breakers,. Potential transformers shall be protected on line and load side.
7. All CT installations shall include 6 place shorting type terminal blocks using 12 gauge wire with ring terminal connectors.
8. All field control interconnect wiring shall be sized as specified by system manufacturer (wiring not designated by the system manufacturer shall be minimum 14 AWG copper). All control interconnect wiring shall be stranded.
9. All active control system components in the system shall be suitable for operation in ambient temperatures ranging from 0 to +50 degrees C. The controls shall be suitable for operation in an ambient ranging from 5-95% relative humidity, and shall be protected from the effects of equipment vibration.
10. The Touchscreen and other non-LED displays specified shall be suitable for operation from 0-50 degrees C. The controls shall be suitable for operation in an ambient ranging from 5-95% relative humidity.

E. System Control Power
   1. Control power for the paralleling system controls shall be derived from the generator 24VDC starting batteries AND a dedicated set of 24VDC station batteries, located within the same room as the paralleling switchgear, sized as recommended by the switchgear supplier, and furnished complete with 120V battery charger, battery rack(s), and all interconnections as required for a complete system. A solid state, no break "best battery" selector system shall be provided so that control voltage is available as long as any battery bank in the system is available, and that all battery banks are isolated to prevent the failure of one battery from disabling the entire system. The power transfer control shall be supplied with redundant DC control power from two independent sources.
   2. The generator set governing, voltage regulation, load sharing, synchronizing, and protection, shall be capable of proper operation with battery voltage levels down to 8vdc without external battery support. The master control shall be supplied with a station battery system rated to 10 amp minimum. The control power for the system master controls shall be derived from at least two different sets of generator set battery banks.
   3. Paralleling breaker control power for each paralleling breaker shall be derived from the generator set and the station batteries for opening, and closing the breakers.

F. SEQUENCE OF OPERATION
   1. Normal Standby Conditions Genset Breakers are open and the Gensets are not running. System loads are supplied by the normal source and may be controlled manually or by a building management system.
   2. Loss of Normal Power The DMC and Gensets receive a start signal from an externally supplied utility monitoring device. The Gensets start automatically and independently and accelerate to rated voltage and frequency. The first Genset closes to the bus as dictated by the First Start System. The remaining Gensets synchronize to the Load Bus and close their respective Genset breakers. The Gensets proportionally share load on the Load Bus. The Load Demand feature will operate if it is enabled.
   3. Return of Normal Power The externally supplied utility monitoring device removes the start signal from the DMC and Gensets. The Genset Breakers open. The Gensets run in cool down mode and then shutdown. The system returns to a Standby mode of operation.
   4. Test Without Load The operator initiates this sequence by selecting the Test Without Load checkbox on the System Control screen. The Gensets start automatically, independently and accelerate to rated voltage and frequency. The first Genset closes to the bus as dictated by the First Start System. The remaining Gensets synchronize to the Load Bus and close their respective Genset Breakers. The Load Demand feature will operate if it is enabled. The operator returns the system to Standby mode from Test Without Load by selecting the Off checkbox on the System Control Screen. The Genset Breakers open. The Gensets run in cool down mode and then shutdown. The system returns to Standby mode of operation.
   5. Genset Bus Overload The Genset bus overload condition occurs when an operational Genset is either at or below 57 Hz for three seconds or at 105% of load for 60 seconds. If Genset bus overload condition occurs, a bus overload alarm initiates on the DMC. A Genset shuts down on overload based on the overload protection settings in the Power Command Control.
   6. Failure Modes

a. Fail to Start If a unit fails to start after the overcrank time delay (time set in the genset control) expires, the unit shuts down and an alarm sounds on the DMC. The operator needs to check and rectify the problem on the Genset at this stage.
b. Fail to Synchronize If a unit fails to synchronize after a preset time delay, an alarm sounds and the unit continues attempting to synchronize until signaled to stop by an operator either on the PCC or on the Genset Control Screen of the HMI on the Digital Master Control.

7. Run Hours Based Sequence Method In this mode, the control automatically select the shut down sequence for the generator sets based on the engine run hours of the Genset, and restarts generators sets in the opposite order. Again, the generator set as the lead or preferred unit never shuts down. The control balances the run hour of the generator sets by creating a sequence based on the current run hours of the generator sets. The generator set with the fewest run hours is set as the lead generator set. The control never shuts down the lead generator set. The generator set with most run hours is the first generator set that will be shut down. The control changes the generator shut down sequence to balance the run hours, based on a threshold set by the operator at the HMI Touch Screen. When the difference in run hours between two generator sets is greater than the threshold, the control switches the two generator sets in the sequence. To initiate the run hour based load demand sequence, the operator must navigate to the system control screen and check the load demand 'ON ENGINE HOURS' check box. The engine run hours can be monitored from the Genset Summary Screen. Upon detection of the lead or preferred Genset failure, the alternative Genset will immediately start and transfer to the bus, releasing the other Genset for maintenance There are two time delays associated with the Load Demand feature. • The Initial time delay is the time delay the DMC waits for the system loads to stabilize before monitoring the load to see if Gensets can be shut down. • The Shutdown time delay is the time delay the DMC waits before issuing a Load Demand Stop to a generator while load conditions are such that the next Genset in the Load Demand sequence should be shutdown. The system returns to the normal load demand sequence described above.
8. Priority Based Load Control
   a. Load Add Sequence The Load Add feature allows the system to have each distribution device assigned to a Load Add Level in the range from 1-8. The amount of load assigned to each load level should be less than the capacity of the smallest sized Genset in the system. More than one distribution device can be assigned to a load add level. When the first Genset Connects to the Load Bus, all distribution devices assigned to load add level 1 will be commanded to add. When the second Genset Connects to the Load Bus, all distribution devices assigned to load add level 2 will be commanded to add. This sequence continues until all Gensets have been added to the Load Bus. If there are more load add levels than Gensets in the system, the DMC will continue to add load levels on a time delay basis until all load add levels in use in the system are added. In the event that not all existing Gensets connect to the Load Bus, the DMC will only add load levels equal to the number of Gensets online. Any further load add levels will need to be added using the manual commands from the Load Control screen. If during the manual adding of load levels, an overload condition occurs, the system will start the Load Shed sequence.
   b. Load Shed Sequence The Load Shed feature allows the system to have each distribution device in the system to be assigned a load shed level in

the range from 0-7. Load Shed level assignment can be automatically done by the DMC based upon the load add level assignments, or can be user defined. Load Shed level 0 will never shed and should be used for critical loads. Load Shed level 1 is the first load to shed when an overload condition has been detected. The load shed feature is activated when the generator detects an overload condition. An overload condition occurs when a PCC of an operational genset senses a frequency at or below 57 Hz for three seconds or at 105% of load for 60 seconds. Upon receiving an overload condition from one or more Gensets, the DMC starts an overload timer. When this timer expires, all distribution devices assigned to Load Shed level 1 open. If the system is still in an overload condition, the DMC waits a time delay (2 Sec) and all Feeder Breakers assigned to Load Shed level 2 open. This sequence continues until the overload condition clears. Once the overload condition is reset, Load Levels may be restored manually using the Restore pushbuttons on the Load Control screen. If during the manual restore of load levels, an overload condition occurs, the system will again start the Load Shed sequence.

2.3. MANUFACTURED UNITS

A. The paralleling/distribution power equipment shall be configured as shown on the contract drawings, and rated for operation at voltage and current levels as shown on the contract drawings. It shall contain devices and equipment as shown on the drawings, in addition to meeting the requirements of this section.

B. Construction (Low Voltage Paralleling and Power Distribution Equipment):

1. Ratings

a. The low voltage switchgear shall consist of an indoor enclosure containing circuit breakers and the necessary accessory components all factory assembled (except for necessary shipping splits) and operationally checked.

b. The assembly shall be a self-supporting and floor mounted on a level concrete pad.

c. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.

d. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum AC service. System voltage will be 277/480 Series Wye volt 3 phase 4 wire with ground.

e. The ampacity of the Low Voltage Switchgear shall be determined by the loading of the feeder circuits.

f. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current as indicated on plans/schedules.

g. All circuit interruption shall be accomplished by the circuit breaker and without the aid of limiter fuses. The circuit breaker short-time ratings shall as specified on the drawings. **

h. The assembly is designed for use on 60Hz electrical systems up to 600 Vac. The assembly shall be properly braced to the ratings of the circuit breaker installed within the assembly.

i. Any items not specifically mentioned but which are obviously necessary for proper operation are implied in this specification.

C. Construction
    1. General
        a. All switchgear/breakers/etc. shall be manufactured by Schneider/Square D or by Eaton/Cutler Hammer.
        b. Each steel section shall contain one or more individual circuit breakers, or instrumentation compartments, and a rear compartment for the buses and outgoing cable connections.
        c. Rigid removable steel base channel shall be provided at the front and rear of each section.
        d. The finish shall be medium gray ANSI #61.
    2. Dimensions
        a. Section widths should be 22, 30, or 36” wide dependent on the size of the circuit breakers being installed.
        b. The lineup shall provide adequate wire bending space for mains and feeders breakers using up to 750 kcmil wires.
        c. Section depth shall be 54” minimum when using 800A feeders. Additional depth to the lineup shall be for the sole purpose of additional wire bending and conduit space.
        d. Adequate conduit space shall be provided to allow all conductors to exit the structure at the same end.
    3. Moving and Handling
        a. The Lineup shall be divided into shipping splits not to exceed 88” wide and shall be capable of being lifted overhead or by a forklift.
        b. Each shipping split shall be provided with removable lifting straps.
        c. Removable Base Channels shall be provided with prying slots for ease of final positioning at the job-site.
        d. For circuit breakers, an overhead or floor mounted lifter shall be provided to ease the installation or removal of circuit breakers in excess of 75 pounds.

D. Breaker Compartment
    1. Circuit Breakers
        a. Each circuit breaker shall be mounted in its own barriered compartment.
        b. Feeder circuit breakers rated 2000A or less shall be capable of being mounted in the uppermost compartment without de-rating.
        c. The front of the circuit breaker shall protrude through the door of the switchboard allowing access to the operational buttons, the toggle mechanism, the trip unit and the display.
        d. All mains and feeders shall be two-step stored energy circuit breakers and shall allow for closed door racking.
        e. All circuit breakers shall be drawout-style construction.
        f. Circuit breakers of like frame sizes shall be interchangeable as standard.
        g. All prepared spaces shall be fully equipped for future devices, including the racking mechanism, bussing, and secondary contacts.
    2. Secondary Connections
        a. All customer secondary control and communications connections shall be made from the front of the switchgear lineup.
        b. A dedicated wiring area accessible from the front shall allow easy access to all control or communications terminations.
        c. Control Connections shall be cage clamp terminals. All control wire shall be 14 gage SIS.

d. Dedicated conduit entry for control wires shall be provided at the top and bottom of each section, capable of landing up to 3 each 1 ½" conduits and accessible from the front.
e. All interconnections between sections at shipping splits shall use locking-pull apart terminal blocks.

3. Instrumentation
   a. Where additional space is required for instrumentation, CPT's, metering, etc., a barriered instrumentation compartment shall be used.
   b. The instrumentation compartment shall not inhibit the routing of control or communication wires.
   c. Individual component mounting surfaces and pans in the instrument compartments shall be painted white as standard.

E. Busing and Cable Compartment
   1. Busing
      a. All vertical and horizontal distribution bussing shall be rated for the full ampacity of the lineup.
      b. All bus joints shall consist of Grade 5 hardware and conical spring (e.g. Belleville) washers to withstand mechanical forces exerted during short circuits. All joints shall consist of a minimum of 2 bolts.
      c. All bus bars shall be silver-plated copper.
      d. All runbacks from the circuit breaker compartment to the cable compartment shall be insulated.
   2. Cable Compartment
      a. All incoming or outgoing power conductors shall be routed through this area.
      b. Feeder Breakers shall have adequate wire bending space regardless of the interrupting rating.
      c. Conduit area for each section shall be a minimum of 17" wide and provide adequate depth for all section conduits.

F. Circuit Breakers and Trip Units
   1. Circuit Breakers
      a. The circuit breaker shall be listed to UL 489
      b. Circuit breakers shall be suitable for the required instantaneous rating without the use of current limiting fuses.
      c. All circuit breakers shall have field interchangeable electrical accessories including shunt trip, spring release, electrical operator, auxiliary contacts, and Trip Unit.
      d. All secondary connections shall be made directly to the front of the circuit breaker cradle.
      e. Each Circuit breaker shall have built in contact temperature and contact wear sensors.
      f. Circuit breaker must be equipped with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell. Circuit breaker must provide a positive ground contact check between the circuit breaker and cell when the accessory cover is removed while the circuit breaker is in the connected, test or disconnected positions.
   2. Trip Units
      a. All trip units shall be removable to allow for field upgrades.
      b. Trip Units shall incorporate "True RMS Sensing", and have LED long-time pickup indications.

c. All trip units shall have the option of turning instantaneously to the off position.
d. Electronic trip unit functions shall consist of adjustable long-time pickup and delay, and instantaneous.
e. Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL Listed as field-replaceable. Adjustable rating plug shall allow for nine long-time pickup settings from 0.4 to 1 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be in nine bands from 0.5–24 seconds at six times Ir.
f. Short-time pickup shall allow for nine settings from 1.5 to 10 times Ir. Short-time delay shall be in nine bands from 0.1–0.4 I2 t ON and 0–0.4 I2 t OFF.
g. Instantaneous settings on the trip units with LSI protection shall be available in nine bands from 2 to 15.
h. All trip units shall have the capability for the adjustments to be set and read locally by rotating a switch.
i. Trip unit shall provide local trip indication
j. Ground-fault protection shall be provided for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of the following types of ground-fault protection: residual, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
k. Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-fault settings for circuit breakers above 1200 A shall be nine bands from 500 to 1200 A.
l. Neutral current transformers shall be provided for four-wire systems.
m. Trip units shall be capable of communicating on MODBUS ® networks.
n. Trip units shall provide additional protection by offering adjustable inverse definite minimum time lag (IDMTL). IDMTL provides optimized coordination by the adjustment of the slope of the long-time delay protection.
o. Trip units shall provide real time metering. Metering functions include current, voltage, power and frequency.

G. Optional Accessories
1. Provide a circuit breaker lifter that is rail-mounted on top of switchgear.
2. A test set shall be available to provide automatic function testing of the circuit breaker. No disassembly of circuit breaker shall be required.
3. Provide phenolic graphics on the front of the entire switchgear lineup to visually represent the flow of power into/through/out of the gear. These phenolic graphics shall include arrows to show the typical direction of power flow (at main breakers, generator breakers and feeder breakers), and shall include symbols for all breakers.

PART 3 - EXECUTION

3.1. POWER COMPANY APPROVAL

A. The paralleling switchgear shall be designed and built to meet all applicable power company requirements for connection to the power company's system, complete with all required relaying/protections to properly protect the power company's systems for reverse power, etc.. Contractor shall ensure that gear is specifically approved by power company for connection to their system prior to proceeding with shop drawings

for the proposed switchgear.

3.2. EXAMINATION

A. The installer shall be responsible for inspection of the site and verification that the equipment can be installed and operated as required by the manufacturer.

3.3. INSTALLATION

A. The equipment shall be installed as recommended by the equipment manufacturer.
B. Remove temporary lifting provisions prior to commissioning.

3.4. IDENTIFICATION

A. Mount permanent operating instructions at each transfer point, and at the system master control. Instructions shall include a one-line system drawing, description of the operating sequences of the system and the manual operation instructions for the panel where they are installed.
B. A notice indicating location of the operation and maintenance manual shall be provided.
C. A notice indicating service support information including supplier name, telephone numbers, and manufacturer's contact information shall be provided on each major piece of equipment.

3.5. CONNECTIONS

A. Ground each piece of equipment according to the requirements elsewhere in Division 26 "Grounding and Bonding for Electrical Systems", and in compliance with instructions in the drawings.
B. Connect power conductors in compliance to appropriate instructions based on voltage class, elsewhere in Division 26.
C. Provide control interconnection wiring and connect all control interconnections in strict compliance to the equipment manufacturers' instructions.

3.6. FIELD QUALITY CONTROL

A. Prior to acceptance testing, test insulation resistance of each switchgear bus, component, connecting supply, feeder, and control circuit (in compliance with equipment manufacturer(s).) Test continuity of each circuit. Retain permanent records of this testing.
B. A factory-authorized and certified service technician shall inspect all control wiring for type of wiring material and installation practice, verify that the wiring is properly installed by point to point testing, and complete installation and startup checks as required by the equipment manufacturer.

3.7. ADJUSTING

A. Set all protective relaying according to the results as required by a coordination study. Set all other settings as recommended by the equipment manufacturer.
B. Record all settings and provide in system operation and maintenance manuals.

3.8. CLEANING

A. All equipment is to be thoroughly cleaned, with any shipping or installation damage repaired, prior to equipment commissioning and final test.

3.9. PROTECTION

A. Equipment shall be protected from the environment in compliance to manufacturer's recommendations. As a minimum, equipment shall be protected from moisture, dirt, and condensation.

3.10. TRAINING

A. Provide a minimum of eight hours of classroom and field training to owner's personnel on the proper use and maintenance of the paralleling switchgear, drawout breakers and generator system(s). Owner shall have the authority to video tape the training for future use/reference.

3.11. DEMONSTRATION.

A. Factory Testing. Before shipment of the equipment to the jobsite, the entire control system (including generator set controls) and all the new switchgear directly controlled by the control system shall have sequence of operation tested at the manufacturer's facility to demonstrate that it is fully functional prior to shipment to the jobsite. No exceptions to the requirements of this paragraph will be accepted.
B. Factory acceptance testing shall be executed successfully prior to shipment from factory.
C. The supplier of the paralleling system shall provide a manufacturer-certified representative to train the owners personnel in the proper operation and maintenance of the paralleling system.

END OF SECTION 26 23 00

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1. SCOPE

A. This section deals with requirements for circuit breaker type switchboards.

PART 2 - PRODUCTS

2.1. SWITCHBOARDS

A. General:
   1. Switchboard shall be totally enclosed, self supporting metal structure, contain industrial type main and distribution molded case circuit breakers and other associated equipment as indicated. The switchboard shall be completely front accessible.
   2. Each switchboard, as a complete unit, shall be given a single integrated equipment rating by the manufacturer. The integrated equipment short circuit rating shall certify that all equipment is capable of withstanding the stresses of a fault equal to that of the least over current protective device contained therein. Such rating shall be established by the actual tests by the manufacturer on a similar equipment construction as the subject switchboard. This test data shall be available and shall be furnished to the engineer, if requested, with or before the submittal or approved drawing. Entire switchboard assembly, including all bussing, shall have SCCR ratings meeting or exceeding the minimum AIC ratings listed on the plans for the switchboard. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. All ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.
   3. Main lugs shall be provided with AL/CU compression lugs suitable for the quantities and sizes of conductors required.
   4. Future Provisions: All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
   5. Top/bottom feed arrangement and lug sizes/quantities shall be coordinated by the contractor.

B. Bussing:
   1. The switchboard bussing shall be silver plated copper and of sufficient cross-sectional area to continuously conduct rated full load current as shown on plans with a maximum temperature rise of 50 degrees C., above an ambient temperature of 25 degrees C. Switchboard shall have a 25% full length ground bus. Neutral bus shall be full capacity. Connections for all current carrying parts shall be bolted. Aluminum bussing is not acceptable. Tapered bussing is not acceptable.
   2. The main horizontal bus shall be located at the back of the switchboard to permit a maximum of available conduit area. The end section shall have bus provisions for future addition. The provisions shall include the bus installed to the extreme side of the switchboard and pre-punched to facilitate future bolted splice plates.

The horizontal main bus supports, connections, and joints shall be bolted with grade 5 carriage bolts and Belleville washers. The main horizontal bus shall be same size, continuous through the board.

2.2. CIRCUIT BREAKERS

A. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.

B. Circuit breakers shall be quick-break, quick-make thermal-magnetic type for alternating current unless noted otherwise. Breakers shall trip free of the handle and tripping shall be indicated by the handle assuming a position between OFF and ON. Multipole breakers shall be internal common trip with single operating handle; external handle ties are not acceptable.

C. All breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated panel. All interrupting ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.

D. Main circuit breakers, 1000 amps and larger, on 277/480 volt, 3 phase, 4 wire systems shall be electronic trip molded case 80% rated equipped with ground fault sensing and automatic trip unless noted otherwise. The following requirements shall be met:
   1. These main breakers shall be equipped with an electric trip device having the following fully-adjustable, time/current response adjustments:
      a. Long Time Pickup.
      b. Long Time Delay.
      c. Short Time Pickup.
      d. Short Time Delay
      e. Ground Fault Pickup.
      f. Ground Fault Delay.
      g. Instantaneous settings.

E. All circuit breakers shall be installed so that the center of the grip of the operating handle, when in its highest position, is not more than 6’-7” above the floor or working platform (the height of the concrete housekeeping pad shall be included in the breaker height calculations).

F. All branch circuit breakers shall be listed to UL489 or shall be specially-tested to be HACR listed.

2.3. SWITCHBOARD FRAMING & CONSTRUCTION

A. The switchboard shall be fabricated on a die-form steel base assembly consisting of formed steel and commercial channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. The framework is to be formed code gauge steel, rigidly welded and bolted together to support all cover plates, bussing, and component devices during service and installation. The dimensions shall be shown on plans. These dimensions shall not be exceeded without specific approval.

B. Each switchboard section shall have one open bottom and individual removable top plate for installation and termination of conduit. Top and bottom conduit area is to be clearly shown and dimensioned on the shop drawings. The wireway front covers are to be hinged to permit access to the branch circuit breaker load side terminals without

removing the covers. All front plates used for mounting meters, selector switches or other front mounted devices shall be hinged with all wiring installed and laced with flexibility at the hinged side. All course plates shall be screw removable and small enough for easy handling by one man. The paint finish shall be gray enamel over a rust-inhibiting phosphate primer, ASA #48.

2.4. ACCESSORIES

A. Each circuit breaker shall have engraved black on white engraved nameplate, providing circuit identification.
B. Provide power meter (with door-mounted display) to monitor, display and alarm relevant current, voltage, power and energy variables. Shall be Square ‘D’ #PM850 or equal.

2.5. MANUFACTURER

A. Switchboard to be manufactured by Square 'D' or Cutler Hammer or approved equal.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Switchboards shall be installed on four inch thick concrete pads unless specifically shown otherwise. Pad shall extend a minimum of 4 inches to all sides of the switchboard and shall have beveled edges.
B. All switchboard dimensions and clearances shall be carefully checked and coordinated with the proper trades to insure proper mounting space and support prior to roughing in equipment.
C. Wiring in panelboard gutters shall be done in a neat and workmanlike manner. Wiring shall be grouped into neat bundles and secured with approved tie wraps.

3.2. SWITCHBOARD IDENTIFICATION

A. Refer to Specification Section 26 05 53.

END OF SECTION 26 24 13

SECTION 26 24 16 - POWER PANELBOARDS - CIRCUIT BREAKER TYPE

PART 1 - GENERAL

1.1. GENERAL

A. The work under this section includes but is not limited to the following:
   1. Power Panelboards
   2. Power Circuit Breakers

PART 2 - PRODUCTS

2.1. PANELBOARDS - GENERAL

A. Panelboards shall be dead front type, having lugs only or circuit breaker in mains as shown in panelboard schedule with circuit breaker branches.
B. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on plans. Such rating shall be established by heat rise test with Maximum hot spot temperature on any connector or bus bar not to exceed 50 degrees C rise above ambient at full rated load. Heat rise test shall be conducted in accordance with UL Standard UL67. Bus structure shall be tin-plated copper. All neutral busses shall be full size. All panelboards shall contain ground buss.
C. Entire panelboard assembly, including all bussing, shall have SCCR ratings meeting or exceeding the minimum AIC ratings listed on the plans for the panel. All ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.
D. Panelboards shall be listed by Underwriters Laboratories and shall bear the UL label. Panelboards shall be suitable for use as service equipment when required.
E. Main and sub-feed lugs shall be provided with AL/CU compression lugs suitable for the quantities and sizes of conductors required.
F. Top/bottom feed arrangement and lug sizes/quantities shall be coordinated by the contractor.
G. Service entrance panelboards shall be provided with barrier such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations**.**

2.2. CIRCUIT BREAKERS

A. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.
B. Circuit breakers shall be quick-make and quick-break, whether actuated automatically or manually. Circuit breakers shall have inverse time tripping characteristics with automatic release which shall trip free of the handle. Circuit breaker handles shall be three distinct positions—“OFF”, “ON”, and “TRIPPED”. When a circuit breaker opens on overload or short circuit, the operating handle shall automatically assume the “TRIPPED” position.
C. Multipole breakers shall be internal common trip with single operating handle. External handle ties are not acceptable, unless specifically noted otherwise (such as for multi-wire branch circuits described below).

D. Circuit breakers feeding multiwire branch circuits (as defined by NEC) consisting of separate single phase loads sharing a common neutral shall be provided with handle ties to simultaneously disconnect all ungrounded conductors per NEC Article 210.4(B). The necessary locations of these handle ties shall be coordinated by the contractor. Where necessary, the contractor may rearrange circuit breakers (as minimally as possible) as required to meet this requirement.
E. Circuit breakers shall be of the bolt-on type.
F. Circuit breakers shall be “FA” frame and larger.
G. All breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated panel. All interrupting ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.
H. The front face of all circuit breakers shall be flush with each other. Breaker numbers shall be permanently attached to trim.
I. All branch circuit breakers shall be listed to UL489 or shall be specially-tested to be HACR listed.

2.3. CABINETS, TRIM AND WIREWAY SPACE

A. Clear space from bottom of lugs to bottom of wireway shall be not less than 6 inches for 400 amps and below, 10 inches for 600 amps, 12 inches for 800 amps and above.
B. Panelboard interiors shall be fastened to cabinets by adjustable aligning supports.
C. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets.
D. Fronts of cabinets shall be made from a single sheet of full finished steel having the door cut out. Doors shall have flush hinges, and lock utilizing all metal construction (with all locks keyed alike). Front shall be attached to cabinets with hinged trim with piano-hinge down full length of one side to allow access to wiring without complete removal of outer trim. Front shall be provided with a metal directory and holder with clear plastic covering welded to the inside of the door. Fronts shall be code gauge full-finished steel with rust inhibiting primer and baked enamel finished in ASA #49 gray. Panelboards installed in corrosive, exterior or wet locations shall have NEMA 4 stainless steel enclosures.
E. Each section of multi-section panelboards shall be of matching heights and depths.
F. Panelboard enclosures shall be furnished as shown on panel schedule on plans for surface, flush or motor control center mounting.

2.4. MANUFACTURER

A. Panelboards shall be as manufactured by Square 'D' or Cutler Hammer.

PART 3 - EXECUTION

3.1. INSTALLATION

A. All panelboard dimensions and clearances shall be carefully checked and coordinated with the proper trades to insure proper mounting space and support prior to roughing in equipment. In no case shall any circuit breaker be located above 6’-7” A.F.F..
B. Wiring in panelboard gutters shall be done in a neat and workmanlike manner. Wiring shall be grouped into neat bundles and secured with approved tie wraps.

3.2. PANEL IDENTIFICATION

A. Refer to Specification Section 26 05 53.

END OF SECTION 26 24 16

SECTION 26 24 17 - LIGHTING PANELBOARDS

PART 1 - GENERAL

1.1. GENERAL

A. The work under this section includes but is not limited to the following:
   1. Lighting Panelboards
   2. Circuit Breakers

PART 2 - PRODUCT

2.1. PANELBOARDS

A. Enclosure:
   1. Panelboards shall be dead front type and shall be in accordance with Underwriter's Laboratories, Inc., standard of panelboards and enclosing cabinets and so labeled.
   2. Panelboards installed in dry locations shall have enclosures fabricated from sheet steel and shall be finished in ASA #49. Panelboards installed in corrosive, exterior or wet locations shall have NEMA 4 stainless steel enclosures.
   3. The door shall have a cylinder type lock. Lock shall be held in place by concealed screw to a captive nut, welded to inside of door. All locks shall be keyed alike.
   4. A metal framed circuit directory card holder with clear plastic covering shall be factory-mounted on the inside of door.
   5. Panels for 20 or more circuits, including spares and spaces, shall be 20 inches wide.
   6. Panelboards enclosures shall be as shown on panel schedule on plans for surface, flush or motor control center mounting.
   7. Provide hinged trim with piano-hinge down full length of one side to allow access to wiring without complete removal of outer trim.
   8. Each section of multi-section panelboards shall be of matching heights and depths.

B. Bussing/Lugs:
   1. Ampacity and service voltage of main buss, lugs or main breakers and branch circuit breakers shall be as shown on drawings.
   2. All bussing and associated connectors shall be tin-plated copper.
   3. All panelboards shall contain ground buss.
   4. Entire panelboard shall be capable of withstanding a short circuit not less than the interrupting capacity of any breaker in the panel. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. Interrupting ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.
   5. Buss connectors shall be for distributed phase arrangement.
   6. Main and sub-feed lugs shall be provided with AL/CU compression lugs suitable for the quantities and sizes of conductors required.

7. Top/bottom feed arrangement and lug sizes/quantities shall be coordinated by the contractor.
8. Entire panelboard assembly, including all bussing, shall have SCCR ratings meeting or exceeding the minimum AIC ratings listed on the plans for the panel. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. All ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.
9. Service entrance panelboards shall be provided with barrier such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

C. Breaker arrangement and numbering:
   1. Panelboards shall be factory assembled with branch breakers arranged exactly as indicated on plans.
   2. Breakers shall be numbered vertically beginning top left. Multi-section panelboards shall be numbered consecutively through all sections.
   3. Breaker numbers shall be permanently attached to trim.
   4. Main breakers shall be vertically-mounted (branch-mounted or back-fed main breakers will not be acceptable unless specifically so shown on plans).

2.2. CIRCUIT BREAKERS

A. Circuit breakers shall be quick break, quick make, thermal magnetic type, for alternating current. Breakers shall trip free for the handle and tripping shall be indicated by the handle assuming a position between OFF and ON.
B. Circuit breakers shall be of the bolt-on type.
C. Multi-pole breakers shall be internal common trip with single operating handle; external handle ties are not acceptable, unless specifically noted otherwise (such as for multi-wire branch circuits described below).
D. Circuit breakers feeding multiwire branch circuits (as defined by NEC) consisting of separate single phase loads sharing a common neutral shall be provided with multi-pole breakers or handle ties to simultaneously disconnect all ungrounded conductors per NEC Article 210.4(B). The necessary locations of these multi-pole breakers or handle ties shall be coordinated by the contractor. Where necessary, the contractor may rearrange circuit breakers (as minimally as possible) as required to meet this requirement.
E. All breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated panel. All interrupting ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.
F. All branch circuit breakers shall be listed to UL489 or shall be specially-tested to be HACR listed.

2.3. SPECIAL REQUIREMENTS

A. Any special requirements on the drawings, such as for increased interrupting rating, ground fault protection, etc., shall supersede these specifications, but only insofar as that particular requirement is concerned.
B. Lighting panels larger than 400A shall conform to the requirements for power panels.

2.4. MANUFACTURER

A. Panelboards shall be as manufactured by Square 'D' or Cutler Hammer.

PART 3 - EXECUTION

3.1. INSTALLATION

A. All panelboard dimensions and clearances shall be carefully checked and coordinated with the proper trades to insure proper mounting space and support prior to roughing in equipment. In no case shall any circuit breaker be located above 6’-7” A.F.F..
B. Wiring in panelboard wireways shall be done in a neat and workmanlike manner. Wiring shall be grouped into neat bundles and secured with approved tie wraps.
C. For all flush-mounted panelboards, a minimum of three (3) one-inch empty conduits shall be stubbed out above the nearest accessible ceiling space for future use.

3.2. PANEL IDENTIFICATION

A. Refer to Specification Section 26 05 53.

END OF SECTION 26 24 17

SECTION 26 24 19 - MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1. DESCRIPTION

A. This section includes requirements for motor control centers (MCC's) and all required control devices as shown on the drawing and specified to be part of the MCC equipment. The MCC shall be 277/480 V, 3-Phase, 4-Wire, 60 Hz unless otherwise indicated.

1.2. SUBMITTALS

A. Submittals shall be furnished in accordance with Specification Section 26 05 00.
B. Submittals shall show separate views of the elevation, profile and conduit openings. The elevation shall show the section identification and the unit identification. The drawings shall give dimensions of size and location of the following:
   1. Vertical section height, width and depth
   2. Mounting channels
   3. Conduit openings top and bottom
   4. Wireway openings in sides
   5. Horizontal buss
   6. Ground buss

C. The submittals shall contain a summary of the design specification containing but not limited to the following:
   1. NEMA type enclosure and class of wiring
   2. Rated buss voltage
   3. Current ratings for horizontal buss, vertical busses and ground buss
   4. Buss material and plating

D. Buss bracing and sheet circuit rating
E. The submittals shall contain a listing of all modifications, options and special equipment.
F. The submittals shall contain a listing of each unit containing but not limited to the following:
   1. Unit Location
   2. Nameplate
   3. Major contents of unit (fuse starter, CB switch, M.C.P., etc.) complete with NEMA size and heater rating or current rating.
   4. Size of load served (H.P. KVA, KW, etc.).

G. Provide the following for each starter/controls unit:
   1. A job-specific, custom wiring diagram
      a. The wiring diagram shall clearly show all control components (whether the components are mounted internal or external to the MCC enclosure).
      b. All wires and terminal blocks shall be clearly labeled.
      c. Diagram shall be in accordance with NEMA/ICS standards.
   2. Size, type and rating of all system components.
   3. Unit frontal elevation and dimension drawings.
   4. Internal component layout diagrams.
   5. Manufacturer's product data sheets for all components.

H. Submittals shall be complete and electrical contractor shall review and approve all accessories required for control wiring prior to submittal

1.3. REGULATORY REQUIREMENTS

A. The MCC shall conform to Underwriters Laboratory (UL) 845, current revision, CSA, EEMAC, NEMA ICS-2, the latest version of the National Electrical Code, and the Canadian Electrical Code. The MCC shall be manufactured in an ISO 9001 certified facility.

1.4. WARRANTY

A. An eighteen-month warranty shall be provided on materials and workmanship from date of owner acceptance/substantial completion after completion of startup.

PART 2 - PRODUCT

2.1. MANUFACTURERS

A. Square 'D' or Cutler Hammer.
B. Additions to existing MCCs shall be the same as the original manufacturer.

2.2. MATERIALS

A. Steel material shall comply with UL 845 and CSA requirements.
B. Each MCC shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, free-standing assembly. A removable 7 gauge structural steel lifting angle shall be mounted full width of the MCC shipping block at the top. 10 gauge bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the shipping block. Vertical sections made of welded side-frame assembly formed from a minimum of 12 gauge steel. Internal reinforcement structural parts shall be of 12 and 14 gauge steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand normal stresses included in transit and during installation.
C. Each entire MCC assembly (including all sub-components) shall be rated to withstand (and provide proper breaker functionality within) the fault current ratings listed on the plans. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. The fault current ratings listed shall be assumed to be at the input terminals of the associated MCC.

2.3. MCC FINISH

A. All steel parts shall be provided with UL and CSA listed acrylic/alkyd baked enamel paint finish, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat.
B. Pre-treatment shall include:
    1. Hot alkaline cleaner to remove grease and oil.
    2. Iron phosphate treatment to improve adhesion and corrosion resistance.

C. The paint shall be applied using an electro-deposition process to ensure a uniform paint

coat with high adhesion.

D. The standard paint finish shall be tested to UL 50 per ASTM B117 (5% ASTM Salt Spray) with no greater than 0.125 in (3 mm) loss of paint from a scribed line.
E. Paint color shall be #49 medium light gray per ANSI standard Z55.1-967 (60-70 gloss) on all surfaces unless specified otherwise. Paint color of additions to existing MCCs shall match that of the existing MCC. Control station plates and escutcheon plates shall be a contrasting gray.

2.4. STRUCTURES

A. Structures shall be totally enclosed, dead-front, free-standing assemblies. Structures shall be capable of being bolted together to form a single assembly.
B. The overall height of the MCC shall not exceed 90 in (2286 mm) (not including base channel or lifting angle). Lifting angles, of 3 in (76 mm) in height, shall be removable. The total width of one section shall be 20 in (508 mm); (widths of 25 in (630 mm), 30 in (760 mm), and 35 in (890 mm) can be used for larger devices). The total depth of each section shall be 20 in (508 mm) unless shown otherwise.
C. Structures shall be NEMA/EEMAC type 1 unless shown/specified otherwise.
D. Each 20 in wide standard section shall have all the necessary hardware and bussing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Vertical bus openings shall be covered by manual bus shutters.
E. Each section shall include a top plate (single piece or two-piece). NEMA/EEMAC type 12 shall also include a bottom plate. Top and bottom plates shall be removable for ease in cutting conduit entry openings.
F. All MCC components, terminations, wiring, etc. shall be fully accessible from the front of the MCC unless noted otherwise.

2.5. WIREWAYS

A. Structures shall contain a minimum 12 in (305 mm) high horizontal wireway at the top of each section and a minimum 6 in (152 mm) high horizontal wireway at the bottom of each section. These wireways shall run the full length of MCC to allow room for power and control cable to connect between units in different sections.
B. A full-depth vertical wireway shall be provided in each MCC section that accepts modular plug-in units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be 4 in (102 mm) wide minimum with a separate hinged door. There should be a minimum of 80 in^2 (516 cm^2) of cabling space available for 20-inch-deep sections. Access to the wireways shall not require opening control unit doors. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units shall open directly into the MCC horizontal wireways.
C. All wireway doors shall be hinged and shall be held shut by captive hardware.

2.6. BARRIERS

A. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece rigid non-conductive barrier. The barrier design shall allow qualified personnel to slide the barriers both left and right, to allow access to the bus and connections for

maintenance without having to remove the barrier. Barrier sliding shall occur via an upper and lower track system.

B. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short circuit. These supports shall have openings every 3 in (75 mm) for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.

C. Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a fishtape inserted through the conduit or wireway areas.

2.7. BUSSING

A. All bussing and connectors shall be tin-plated copper.

B. The main horizontal bus shall be rated as indicated on plans and shall extend the full length of the MCC. Bus ratings shall be based on 65° C maximum temperature rise in a 40° C ambient. Provisions shall be provided for splicing additional sections onto either end of the MCC.

C. The horizontal bus splice bars shall be pre-assembled into a captive bus stack. This bus stack is installed into the end of the MCC power bus to allow the installation of additional sections. The main bus splice shall utilize four bolts, two on each side of the bus split, for each phase. Additional bolts shall not be required when splicing higher amperage bus. The splice bolts shall secure to self clenching nuts installed in the bus assembly. It shall be possible to maintain any bus connection with a single tool.

D. A neutral bus and/or neutral lugs (with amperage rating equal to that of the main horizontal bus) shall be provided for all 4-wire motor control centers.

E. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of copper and plating as the main bus, and shall be rated 300 A or 600 A continuous based on UL standards (and the associated loads connected to the bus). The vertical bus shall be connected directly to the horizontal bus stack without the use of risers or other intervening connectors. It shall be possible to maintain the vertical to horizontal bus connection with a single tool. "Nut and bolt" bus connections to the power bus shall not be permitted. When a back-to-back unit arrangement is utilized, separate vertical bus shall be provided for both the front and rear units.

F. A tin-plated copper ground bus shall be provided that runs the entire length of the MCC. The ground bus shall be rated for 25% (minimum) of the main horizontal bus amperage. Compression lugs shall be provided in the MCC for a ground cable, sized to accommodate the grounding connections shown on plans. The ground bus shall be provided with six (6) holes for each vertical section to accept customer-supplied ground lugs for any loads requiring a ground conductor.

G. Each vertical section shall have a tin-plated copper vertical ground bus that is connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.

H. The system shall be rated for an available short circuit capacity as indicated on plans. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings.

Interrupting ratings shall be full ratings. Series ratings will not be allowed unless specifically shown otherwise on drawings.

2.8. TYPICAL UNIT CONSTRUCTION

A. Units with circuit breaker disconnects through 400 A frame, and fusible switch disconnects through 400 A, shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.
B. All circuit breakers rated (or able to be adjusted to) 1200A or higher shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.
C. All circuit breakers shall have adjustable magnetic trip settings. Provide a field adjustable breaker to allow for one breaker for each NEMA size starter. The adjustment range shall include current range to encompass the entire range of each size starter. There shall also be adjustments to select either standard or high inrush magnetic settings, from 6 times to 13 times motor full load current. If a standard, non adjustable, magnetic only trip breaker is furnished for a combination starter unit, the manufacturer shall include in the bid cost to furnish and install replacement breakers at jobsite if equipment changes dictate.
D. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.
E. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All plug-on units shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-on unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment.
F. A lever handle operator shall be provided on each disconnect. With the unit stabs engaged onto the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit. All circuit breaker operators shall include a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door. Clear indication of disconnect status shall be provided, by adhering to the following operator handle positions:
    1. Handle "On" position shall be up or to the left and within 45 degrees of being parallel to the face of the equipment.
    2. Handle "Off" position shall be down or to the right and within 45 degrees of being parallel to the face of the equipment.
    3. The minimum separation between the "On" and "Off" positions shall be 90 degrees.
    4. On Circuit Breaker disconnects, the handle "Tripped" position shall be perpendicular to the face of the equipment +/- 30 degrees. Minimum separation between "On" and "Tripped" shall be 30 degrees. Minimum separation between "Tripped" and "Off" shall be 45 degrees.

G. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.
H. A non-defeatable interlock shall be provided to prevent installing or removing a plug-in unit unless the disconnect is in the OFF position.
I. The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.

J. Provisions shall be provided for locking all disconnects in the OFF position with up to three padlocks.
K. Handle mechanisms shall be located on the left side to encourage operators to stand to the left of the unit being switched.
L. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.
M. All unit doors shall be hinged and shall be held shut by captive hardware.
N. Interiors of all units shall be painted white.

2.9. COMPONENTS FOR TYPICAL UNITS

A. Main Lugs
1. Main and sub-feed lugs shall be provided with AL/CU compression lugs suitable for the quantities and sizes of conductors required.

B. Circuit Breakers
1. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.
2. Circuit breakers shall be quick-make and quick-break, whether actuated automatically or manually. Circuit breakers shall have inverse time tripping characteristics with automatic release which shall trip free of the handle. Circuit breaker handles shall be three distinct positions—“OFF”, “ON”, and “TRIPPED”. When a circuit breaker opens on overload or short circuit, the operating handle shall automatically assume the “TRIPPED” position.

C. Combination Starters
1. All combination starters shall utilize a unit. Magnetic starters shall be furnished in all combination starter units unless specifically shown otherwise. All starters shall utilize full NEMA/EEMAC rated contactors (size 1 minimum).
2. Starters shall be provided with a three-pole, external (door mounted) manual reset, solid state overload relay . Solid state overload relay shall have switch-selectable trip class and shall provide protection from:
a. Overload.
b. Phase Unbalance.
c. Phase Loss.
d. Ground Fault (Class II detection).
3. Unless specifically shown otherwise, each combination starter shall be furnished with a control circuit transformer including two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads (including motor space heaters and other similar loads where specified). The transformer rating shall be fully visible from the front when the unit door is opened. Unless otherwise indicated, control voltage shall be 120V AC. Control power shall be provided by individual unit control power transformers.
4. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
5. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.

6. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.
7. Each starter shall be equipped with a minimum of the following control devices:
    a. Door-mounted reset button.
    b. Two (2) field-reversible (N.O./N.C.) auxiliary contacts
    c. For reversing and two-speed starters: Four (4) field-reversible (N.O./N.C.) auxiliary contacts
    d. Additional control devices as indicated on plans.

D. Terminal Blocks
1. Wiring within all units shall be type B, with unit-mounted control terminal blocks for each field wire.
2. Terminal blocks shall be the pull-apart type 600 volt and rated at 25 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.

E. Nameplates
1. Each unit shall be properly labeled with an engraved phenolic nameplate with a white background and black letters.
2. Each pilot device shall be properly labeled with a legend plate or an engraved phenolic nameplate.

F. Wiring
1. All wiring shall be identified on each end with hot stamped or shrink tube type permanent wire markers to correspond with numbering shown on wiring diagrams.

G. Wiring Diagram
1. A job-specific, custom wiring diagram for each unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to each unit (whether the components are mounted internal or external to the soft start enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.

H. Control Components:
1. All pushbuttons, pilot lights, selector switches and other control devices shall be separate, standard size (full 30mm) and shape, heavy duty oil-tight units.
2. All pilot lights to be cluster LED type & push to test.
3. Relays:
    a. Control relays shall have the following characteristics, unless noted otherwise:
        1) General purpose, plug-in type.

2) Minimum mechanical life of 10 million operations.
3) Coil voltage as indicated or required by application.
4) Single-break contacts rated 12 amperes, resistive at 240 volts.
5) Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each individual relay shall have 3PDT contacts. Where required, multiple control relays shall be provided (to provide the required quantities of contacts) for each “relay” function shown on plans/diagrams.
6) Furnished with RC transient suppressor to suppress coil-generated transients to 200% of peak voltage.
7) LED on/off indicator light and manual operator.
8) Industry standard wiring and pin terminal arrangements.
9) Equal to Square D 8501KP series with matching plug-in socket.

b. Interposing/isolation relays used to isolate input/output field wiring from PLC inputs/outputs shall be terminal-block style. Terminal-block style relays shall have the following characteristics, unless noted otherwise:
1) Minimum mechanical life of 10 million operations.
2) Single-break contacts rated 6 amperes, resistive at 120 volts.
3) One (1) N.O. contact per relay.
4) Furnished with integral transient protection.
5) LED on/off indicator light.
6) DIN-rail mounted.
7) Equal to Square D type Zelio RSL.

c. Timer relays shall be electronic, adjustable plug-in devices meeting the following characteristics, unless noted otherwise:
1) General purpose, plug-in type.
2) Minimum mechanical life of 10 million operations.
3) Single-break contacts rated 10 amperes, resistive at 240 volts.
4) Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each relay shall have DPDT contacts (2 N.O. & 2N.C.). Where required, multiple timer or control relays shall be provided (to provide the required quantities of contacts) for each “relay” function shown on plans/diagrams.
5) Rotary-thumbwheel adjustments for time value, timing range and function.
6) Time value adjustments from .05 seconds to 999 hours
7) Selectable Timing Functions, including the following:
(a) On Delay
(b) Interval
(c) Off Delay
(d) One Shot
(e) Repeat Cycle-Off
(f) Repeat Cycle-On
(g) On/Off Delay
(h) One Shot Falling Edge
(i) Watchdog
(j) Trigger On Delay
8) Accuracy shall be $\pm$ 2% and repeatability shall be $\pm$ 0.1%.
9) Furnished with integral transient protection.
10) LED indicator light(s) for “timing” and “on/off status”

11) Held in place with hold-down spring
12) Equal to Square D type JCK with matching plug-in socket.

2.10. VARIABLE FREQUENCY DRIVES

A. Refer to Section 26 29 23.

2.11. QUALITY CONTROL

A. The entire MCC shall go through a quality inspection before shipment. This inspection shall include:
   1. Physical Inspection of:
      a. Structure.
      b. Electrical conductors, including:
         1) bussing.
         2) general wiring.
         3) units.
   2. Electrical Tests
      a. General electrical tests include:
         1) power circuit phasing.
         2) control circuit wiring.
         3) instrument transformers.
         4) meters.
         5) ground fault system.
         6) device electrical operation.
      b. AC dielectric tests shall be performed on the power circuit.
   3. Markings/Labels, include:
      a. instructional type.
      b. Underwriters Laboratory (UL)/Canadian Standards Association (CSA).
      c. inspector's stamps.
   4. The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

B. The motor control center design shall be in accordance with the latest applicable standards of NEMA and Underwriters Laboratories.

2.12. SPECIAL REQUIREMENTS

A. Where the schedules and diagrams show deviations from these Specifications, the schedules and diagrams shall take precedence, but only for the particular feature.

PART 3 - EXECUTION

3.1. PACKING/SHIPPING

A. The MCC shall be separated into shipping blocks no more than three vertical sections each. Shipping blocks shall be shipped on their sides to permit easier handling at the jobsite. Each shipping block shall include a removable lifting angle, which shall allow an easy means of attaching an overhead crane or other suitable lifting equipment.

3.2. STORAGE

A. If the MCC cannot be placed into service reasonably soon after its receipt, store it in a clean, dry and ventilated building free from temperature extremes. Acceptable storage temperatures shall be determined by the manufacturer. Anti-condensation space heaters shall be provided during equipment storage as directed by the manufacturer.

3.3. LOCATION

A. Motor control centers shall not be placed in hazardous locations. The area chosen shall be well ventilated and totally free from humidity, dust and dirt. Where the minimum temperature of the area is less than 0° C (32° F), space heaters shall be provided within the motor control center. Where the minimum temperature of the area is greater than 40° C (104° F) ventilation fans and/or air conditioning units shall be provided within the motor control center as required to provide adequate cooling for each unit. For indoor locations, protection shall be provided to prevent moisture entering the enclosure .
B. Motor control centers shall be located in an area with a minimum of 4 ft (1219 mm) of free space in front of front-of-board construction. This free space shall give adequate room to remove and install units. A minimum of 0.5 in (13 mm) space should be provided between the back of front-of-board MCCs and a wall, 6 in (152 mm) required for damp locations.
C. The MCCs shall be assembled in the factory on a smooth level surface so that all sections are properly aligned. A similar smooth and level surface shall be provided for installation. An uneven foundation will cause misalignment of shipping blocks, units, and doors. The surface under a MCC shall be of a non-combustible material unless bottom plates are installed in each vertical section.

3.4. INSTALLATION

A. Motor control centers shall be installed on six inch thick concrete pads unless specifically shown otherwise. Pad shall extend a minimum of four inches to all sides and shall have beveled edges.
B. Orientation of motor control centers shall be as shown on the Engineer’s drawings. Space requirements are critical on this project and therefore special care shall be taken to insure that equipment will fit in the designated space. To insure proper coordination, the MCC manufacturer shall submit with shop drawings a 1/2”=1’-0” scale floor plan of each electrical room showing all columns, doors, walls and proposed equipment. Manufacturer shall not bid equipment that will not fit in available space.
C. All motor control center dimensions and clearances shall be carefully checked and coordinated with the proper trades to insure proper mounting space and support prior to roughing in equipment.
D. Motor control centers shall be grounded in two places as specified on drawings.
E. Verify all accessories as shown on drawings. Perform all necessary additions and modifications to make the motor control center to the Engineer’s drawings.
F. A job-specific, custom wiring diagram for each unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to each unit (whether the components are mounted internal or external to the soft start enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.
G. Operations and Maintenance Manuals and a listing of the nearest and most convenient source of replacement parts and service shall be provided to the owner for all MCC

components, control wiring, etc.

H. Operations and Maintenance Manuals shall include hardcopy printouts of all device settings and programming.

I. For safety, reliability, and continuity of warranty, any modifications, alterations, etc. required to conform to the requirements of this specification shall be performed by the MCC manufacturer only. Distributor modifications, third party packaging, etc. of a manufacturer's standard product are specifically disallowed.

J. Services shall include a minimum of eight (8) hours of field/classroom training for owner's personnel on routine operation and maintenance of the specified units.

3.5. SPARE PARTS

A. The following spare parts shall be provided at no extra cost to the Owner:
   1. One of each type and size of control fuse.

END OF SECTION 26 24 19

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1. DESCRIPTION

A. Wiring Devices
B. Plates
C. Finishes

PART 2 - PRODUCTS

2.1. WIRING DEVICES AND PLATES

A. Switches shall be AC type, extra-heavy duty industrial grade (unless otherwise shown) of ratings shown on drawings. Switches shall be as manufactured by Hubbell, P & S, Sierra, Bryant, GE, Arrow Hart or equal.
B. Receptacles shall have blade configuration and shall be extra-heavy duty industrial grade (unless otherwise shown) of current and voltage rating as shown on drawings. Receptacles shall be as manufactured by Hubbell, P & S, Sierra, Bryant, GE, Arrow Hart or equal.
C. All GFCI-type receptacles shall continuously self-test and shall trip/deny power if the receptacle does not provide proper GFCI protection or if the line/load terminations are miswired and shall provide visual indication of power status, trip conditions, ground fault conditions and end-of-life status.
D. Each wiring device shall have a plate (see “Finishes” section below for specific requirements).

2.2. FINISHES

A. All wiring devices (switches, receptacles, etc.) shall be colored to match the coverplates described below. For instance, all items covered by stainless steel, aluminum or malleable iron plates shall be gray in color.
    1. Exceptions:
        a. Emergency wiring devices shall be red.
        b. Isolated ground wiring devices shall be orange.

B. Coverplates for recessed, wall-mounted electrical items (switches, receptacles, telephone outlets, etc.) shall be stainless steel unless shown otherwise.
C. Coverplates, trim rings, etc. for recessed, floor-mounted electrical items (floor outlets, underfloor duct junctions, etc.) shall match finish of building hardware (302/304 stainless steel, brass, etc.) in area installed.
D. Coverplates for exposed electrical items (switches, receptacles, telephone outlets, etc.) shall be of same material as exposed boxes (see Outlet Box Specification for required material type) and shall have beveled edges.
E. Coverplates for receptacles in wet locations shall be metallic, in-use type, rated for wet locations per NEC requirements unless noted otherwise.
F. See “Electrical Identification” specification section for coverplate labeling requirements.

PART 3 - EXECUTION

3.1. GENERAL MOUNTING

A. Symbols on drawings and mounting heights are approximate. The exact locations and mounting heights shall be determined on the job, and it shall be the Contractor's responsibility to coordinate with all trades to secure correct installation. For example, Contractor shall coordinate exact mounting heights over counters, in or above backsplashes, in block walls, and at other specific construction features.
B. Verify all door swings with Architectural. Locate boxes for light switches within four inches of door trim on swing side (not hinge side) of door.
C. Devices and associated plates shall not be used as support; outlet boxes shall be rigidly supported from structural members.
D. Mount all straight-blade receptacles vertically with ground pole up, unless specifically noted otherwise.
E. Unless otherwise shown or required by local handicap codes, outlet boxes shall be the following distances above the finished floor unless otherwise noted.
    1. Receptacles and telephone outlets in offices and other finished areas: 1’-6” to the center of the box.
    2. Receptacles and telephone outlets in equipment rooms and other unfinished areas: 4’-0” to the center of the box.
    3. Receptacles over counters: As Noted
    4. Switches, general: 4’-0” to the top of the box.
    5. Push-button, etc., general: 4’-0” to the top of the box.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1. GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:
   1. Fuses

PART 2 - PRODUCTS

2.1. FUSES

A. Fuses - 600 volts and less - shall be furnished and installed by electrical contractor who will maintain fuses in original new condition until installed. Fuses shall not be installed until equipment is ready to be energized.
B. Fuses 601 to 6000 amperes shall be time-delay, Class L type with an “O” ring to provide seal between the end bells and the glass melemine fuse barrel. Terminals shall be penned. Fuses must hold 500% rating for a minimum of 4 seconds and clear 20 times rated current in .01 seconds or less. Fuses shall be current-limiting and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes r.m.s. symmetrical. Bussmann Hi-Cap, time-delay, Class L fuses.
C. All other fuses for power, light and motor circuits shall be dual-element, Class RK5 type with separate overload and short-circuit elements. The overload element shall incorporate a spring activated thermal unit having a 284 Degree Fahrenheit melting point alloy and with a heat sink that will provide time-delay of a minimum of 10 seconds at 500% rating. Fuses shall be current-limiting and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes r.m.s. symmetrical. Bussmann Low-Peak, dual-element, Class RK5 fuses.
D. Fuses shall be installed in fluorescent fixtures on the line side of the ballast by the fixture manufacturer who will size the fuses for each application. Bussmann GLR fuses installed in HLR fuseholder.
E. Fuses for all other ballast-controlled lighting fixtures shall have fuses installed on the line side of the ballast either in the housing or handhole of lighting standards for easy access. Bussmann FNQ fuse with HPF holder for all applications. Bussmann FNQ fuse with HPF holder for all applications except lighting Standards where Bussmann HEB-JJ holder with FNQ fuse will be used.

2.2. MANUFACTURER

A. Fuses shall be as manufactured by Bussmann Manufacturing or approved equal. Approved substitutions will be allowed that provide required electrical safety overload and short-circuit performance. Electrical contractor shall submit one copy each of fuse and fuse holder manufacturers bulletins that fully describe performance for substitution approval consideration. The bulletins shall be submitted to the Electrical Design Engineer at time of bid submittal.

PART 3 - EXECUTION

3.1. SPARE FUSES

A. Spare fuses shall be provided by the electrical contractor. 10% (minimum of 3) of each size and type will be placed in a Spare Fuse Cabinet mounted on the wall of the electrical room.

END OF SECTION 26 28 13

SECTION 26 28 16 - SAFETY SWITCHES AND FUSES

PART 1 - GENERAL

1.1. DESCRIPTION

A. Safety Switches
B. Fuses
C. Branch Feeders
D. Feeders

PART 2 - PRODUCTS

2.1. SAFETY SWITCHES

A. Safety switches shall be quick-make, quick-break, NEMA heavy duty type HD, fused or nonfused as shown. Switch blades shall be fully visible in the off position.
B. Safety switches shall be furnished with transparent internal barrier kits to prevent accidental contact with live parts. Barriers shall provide finger-safe protection when the switch door is open and shall allow use of test probes and removal of fuses without removing barrier.
C. Fused switches shall have provisions for class R, rejection type fuses.

2.2. FUSES (600V)

A. Fuses for all branch switches shall be Bussman Mfg. Co., Dual Element, Class “R” Fusetron.
B. Fuses for main switch/switches shall be Bussman Mfg. Co. Hi-Cap.

2.3. MANUFACTURER

A. Safety switches shall be as manufactured by Square 'D' or Cutler Hammer.
B. Fuses shall be as manufactured by Bussman Mfg. Co. or equal.

PART 3 - EXECUTION

3.1. SAFETY SWITCHES

A. Safety switches shall be installed as shown on the plans and in accordance with N.E.C.
B. Locations shown for safety switches on plans are diagrammatical only. Exact locations shall be field coordinated by contractor as required to provide code-required clearances.
C. Switch enclosures shall be rated NEMA I indoors in dry locations and NEMA 4 stainless steel outdoors and in wet or process areas.
D. Adequate support shall be provided for mounting safety switches. Safety switches shall not be mounted to the associated equipment (unless the safety switch is furnished with the equipment).

3.2. FUSES

A. Fuses shall be sized as shown on drawings, unless a smaller size is required by the

associated equipment supplier, in which case the contractor shall provide fuses sized as directed by the associated equipment supplier at no additional cost.

B. Provide not less than one spare set of fuses for each size used. Provide an additional spare set for each five sets of same size fuses used.

END OF SECTION 26 28 16

SECTION 26 29 00 - MANUFACTURED CONTROL PANELS

PART 1 - GENERAL

1.1. SCOPE

A. This section describes control stations, PLC panels, motor control panels, manufactured control panels, and other similar panels specified herein. Specifications herein are intended as an extension of requirements in other Divisions of these specifications where reference is made to Electrical Specifications.

1.2. DEFINITIONS

A. "Control Stations": Enclosures (with all required accessories) containing only door-mounted pushbuttons, indicator lights and/or selector switches (no electronic components or starter/controller equipment).
B. "Control Panels": Enclosures (with all required accessories) containing equipment/devices other than door-mounted pushbuttons, indicator lights and/or selector switches (such as electronic components, starter/controller equipment, etc.).

1.3. SUBMITTALS

A. Provide the following for each control panel:
    1. A job-specific, custom wiring diagram
        a. The wiring diagram shall clearly show all components (whether the components are mounted internal or external to the control panel enclosure).
        b. All wires and terminal blocks shall be clearly labeled.
        c. Diagram shall be in accordance with NEMA/ICS standards.
    2. Size, type and rating of all system components.
    3. Unit frontal elevation and dimension drawings.
    4. Internal component layout diagrams.
    5. Manufacturer's product data sheets for all components.

B. A Bill of Materials shall be included with catalog information on all components.
C. Information shall be included on any proprietary logic component sufficient to demonstrate its ability to perform the required functions.
D. The following calculations shall be submitted:
    1. Thermal calculations showing amount of air conditioning or ventilation and heating required for each control panel, per ambient requirements listed below and operating temperature limitations of all equipment/devices within each control panel. Where possible, forced air ventilation shall be utilized rather than air conditioning. Panel shall be oversized, interior equipment/devices shall be derated, and solar shielding shall be provided as required to allow the use of forced air ventilation as the cooling method. Air conditioning, ventilation, and/or heating equipment shall each have ratings/capacities at least 20% larger than required by calculations below unless noted otherwise:
        a. Thermal calculations used for sizing cooling/ventilation systems for each control panel located in exterior or non-conditioned spaces shall assume:
            1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.

2) Full solar contact where applicable (not applicable where enclosures are fully protected from solar contact using solar shields separated from panel enclosure with standoffs or similar).
3) No wind.
4) Heat loss from interior equipment (electronics, etc.) per equipment supplier's information.

b. Thermal calculations used for sizing heating systems for each control panel shall assume:
1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.
2) No heat loss by interior components of control panel.
3) No solar gain on exterior of control panel.
4) Doubling of heating wattage required to account for wind where control panels are located outdoors.
5) Minimum temperature difference (due to heating) of 10 degrees F to prevent condensation, regardless of equipment temperature limitations.

2. Load calculations showing the sizing of all power supplies provided (with spare capacity as specified). Power supplies shall each have ratings/capacities at least 20% larger than required by load calculations unless noted otherwise.
3. Load calculations showing the sizing and anticipated runtime of all Uninterruptible Power Supply systems provided (with spare capacity as specified).

PART 2 - PRODUCTS

2.1. GENERAL

A. Control panels shall be Underwriters' Laboratories labeled by the panel manufacturer. Control panel manufacturers not capable of applying the U.L. label to their products are unacceptable.
B. All human interface equipment/devices (indicator lights, selector switches, pushbuttons, time switches, displays, keypads, and other similar items used for control, adjustments or monitoring) shall be mounted on the non-energized side of enclosure door(s) in such a way as to be accessible without exposing the user to energized parts.

2.2. RATINGS

A. All Control Panels shall have short circuit current ratings at least equal to the lesser of the following, unless noted otherwise on plans:
1. The short circuit current rating of the electrical distribution equipment that feeds the Control Panel.
2. 150% of the available fault current at the Control Panel as determined by a Short Circuit Current study prepared by a licensed professional electrical engineer.

B. All equipment/devices installed within control panels shall be rated to operate in ambient temperatures of 50 degrees C (122 degrees F) or higher.

2.3. ENCLOSURES

A. All enclosures (with any required accessories or auxiliary items) shall fit within the space shown on the Plans. Any costs associated with furnishing equipment which exceeds

the available space shall be borne by the Contractor.

B. Enclosures (with any required accessories or auxiliary items) shall be suitable for the environment where installed.

C. Enclosure materials shall be as follows unless noted otherwise:
   1. Control Stations:
      a. Where located in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.): NEMA 4X of non-metallic construction (with non-metallic hardware) compatible with the associated chemical(s).
      b. Where located in other wet, process or outdoor areas: NEMA 4X of type 304 stainless steel construction (with stainless steel hardware).
      c. Where located in dry, non-process, indoor areas (such as electrical rooms): NEMA 1 of die cast zinc/aluminum construction.
   2. Control Panels:
      a. Where located in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.): NEMA 4X of non-metallic construction (with non-metallic hardware) compatible with the associated chemical(s).
      b. Where located in other wet, process or outdoor areas: NEMA 4X of type 316 stainless steel construction (with stainless steel hardware).
      c. Where located in dry, non-process, indoor areas (such as electrical rooms): NEMA 1 or 12.

D. Control Panel Enclosure Construction:
   1. Non-metallic control panel enclosure material, where specified, shall be reinforced polyester resin or equivalent, with a minimum thickness of 3/16 inch for all surfaces except those requiring reinforcement. Panels shall be precision molded to form a one piece unit with all corners rounded. Exterior surfaces shall be gel-coated to provide a corrosion-resistant maintenance-free satin finish which shall never need painting. Color pigments shall be molded into the resin. Color shall be grey.
   2. Metallic control panel enclosures, where specified, shall be fabricated using a minimum of 14 gauge steel for wall or frame mounted enclosures and a minimum of 12 gauge for freestanding enclosures. Continuously weld all exterior seams and grind smooth. Reinforce sheet steel with steel angles where necessary support equipment and ensure rigidity and preclude resonant vibrations.
   3. Use pan-type construction for doors.
   4. Door widths shall not exceed 36-inches.
   5. Mount doors with full length, heavy duty piano hinge with hinge pins.
   6. Provide gasket completely around each door opening.
   7. Mount and secure all internal components to removable back plate assembly.
   8. For NEMA 1 or 12 enclosures, provide handle-operated key-lockable three point stainless steel latching system for each door.
   9. For NEMA 4X enclosures, provide provisions for padlocking all doors and provide clamps on three (3) sides of each door.

E. Control panel enclosures (and associated backpanels and other similar accessories) shall be manufactured by Hoffman Engineering Co., or Saginaw Control & Engineering.

2.4. CONTROL PANEL ACCESSORIES:

A. Cooling systems shall be provided if so required by the application to maintain temperatures within the acceptable ranges of the interior equipment. In no case

(regardless of temperature ratings of internal equipment) shall maximum temperatures within control panels be allowed to exceed 50 degrees C (122 degrees F). Thermostats shall be provided to control cooling without need of manual operation. Thermostat setpoints shall be as per recommendations of the equipment suppliers. See above for thermal calculation requirements. Cooling units shall be as manufactured by Hoffman Engineering Co., Rittal or approved equal and shall be thermostatically controlled.

B. Space heaters shall be provided for condensation and temperature control. Thermostats AND hygrostats (or combination hygrotherm controllers) shall be provided to control heating requirements (based on temperature and relative humidity within enclosure) without need of manual operation. Setpoints shall be as per recommendations of the equipment suppliers. See above for thermal calculation requirements. Space heaters and associated control devices shall be as manufactured by Hoffman Engineering Co., Rittal, Stego or approved equal.

C. NEMA 4X control panels shall be provided with vapor-phase corrosion inhibitor(s) (chemical combinations that vaporize and condense on all surfaces in the enclosed area, to protect metal surfaces/devices within the enclosed area from corrosion). Corrosion inhibitor shall be Hoffman #AHCI series (sized as required by the enclosure volume to be protected) or equal.

D. For outdoor panels, stainless steel solar shields for front, top and each side of panel, supported to associated panel face with standoffs as required (to allow free air flow between solar shield and panel enclosure), shall be provided where required to limit solar loading on panel to allow use of a ventilated panel design rather than an air-conditioned panel design.

E. Provide a sun shield over all LCD displays in exterior-mounted panels. Sun shield shall be collapsible to fully protect LCD display from UV light when not in use, shall provide side and top shielding when in use, shall be constructed of stainless steel and shall be installed such as to maintain NEMA 4X ratings of enclosures.

F. Provide a clear polycarbonate gasketted hinged door or window to encompass all indicators, controllers, recorders, etc. mounted on NEMA 4 and 4X enclosures.

G. Provide interior mounting panels and shelves constructed of minimum 12 gauge steel with white enamel finish. Provide metal print pocket with white enamel finish on inside of door.

H. Provide interior LED light kit, mounted at top of interior of panel, and switched to turn “ON” when door is opened for the following control panels:
   1. Control panels with outer dimensions greater than 20” wide or 30” high.
   2. Control panels containing PLCs or other similar programmable devices.

I. Control panels containing VFDs or Reduced Voltage Soft Starters shall include a door mounted digital keypad for adjusting the starter parameters and viewing process values and viewing the motor and starter statuses without opening the enclosure deadfront door.

2.5. CONTROL COMPONENTS

A. General:
   1. All pushbuttons, pilot lights, selector switches and other control devices shall be separate, standard size (full 30mm) and shape, heavy duty oil-tight units.
      a. Devices in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.) shall be of non-metallic construction.
      b. Devices in other areas shall be of chrome-plated construction.

2. All components and devices so that connection can be easily made and so there is ample room for servicing each item.
3. Door-mounted indicators, recorders, totalizers and controllers shall be located between 48” and 72” above finished floor level.
4. Door-mounted indicator lights, selector switches and pushbuttons shall be located between 36” and 80” above finished floor level.
5. All devices and components shall be adequately supported to prevent movement. Mounting strips shall be used to mount relays, timers and other devices suitable for this type of mounting.

B. Pilot Lights:
   1. All pilot lights to be cluster LED type & push to test.

C. Pushbuttons:
   1. All STOP operators within control stations located at equipment shall be provided with lockout provisions and a minimum of two (2) sets of contact blocks.
   2. Emergency shutoff pushbutton devices shall be as follows unless noted otherwise:
      a. 2 ¼” diameter, mushroom-style, maintained contact push buttons
      b. With a minimum of one (1) normally open dry contact and three normally closed dry contacts.
      c. Connections made such that pushing “in” the button will shutoff the associated equipment.
      d. Provided with a red engraved nameplate with ½” lettering to read “Emergency Shutoff”.

D. Relays:
   1. Control relays shall have the following characteristics, unless noted otherwise:
      a. General purpose, plug-in type.
      b. Minimum mechanical life of 10 million operations.
      c. Coil voltage as indicated or required by application.
      d. Single-break contacts rated 12 amperes, resistive at 240 volts.
      e. Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each individual relay shall have 3PDT contacts. Where required, multiple control relays shall be provided (to provide the required quantities of contacts) for each “relay” function shown on plans/diagrams.
      f. Furnished with RC transient suppressor to suppress coil-generated transients to 200% of peak voltage.
      g. LED on/off indicator light and manual operator.
      h. Industry standard wiring and pin terminal arrangements.
      i. Equal to Square D 8501KP series with matching plug-in socket.
   2. Interposing/isolation relays used to isolate discrete output field wiring (and where required for voltage translation for other discrete signals) to/from PLC inputs/outputs shall be terminal-block style. Terminal-block style relays shall have the following characteristics, unless noted otherwise:
      a. Minimum mechanical life of 10 million operations.
      b. Single-break contacts rated 6 amperes, resistive at 120 volts.
      c. One (1) N.O. contact per relay.
      d. Furnished with integral transient protection.
      e. LED on/off indicator light.
      f. DIN-rail mounted.

g. Equal to Square D type Zelio RSL.

3. Timer relays shall be electronic, adjustable plug-in devices meeting the following characteristics, unless noted otherwise:
   a. General purpose, plug-in type.
   b. Minimum mechanical life of 10 million operations.
   c. Single-break contacts rated 10 amperes, resistive at 240 volts.
   d. Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each relay shall have DPDT contacts (2 N.O. & 2N.C.). Where required, multiple timer or control relays shall be provided (to provide the required quantities of contacts) for each "relay" function shown on plans/diagrams.
   e. Rotary-thumbwheel adjustments for time value, timing range and function.
   f. Time value adjustments from .05 seconds to 999 hours
   g. Selectable Timing Functions, including the following:
      1) On Delay
      2) Interval
      3) Off Delay
      4) One Shot
      5) Repeat Cycle-Off
      6) Repeat Cycle-On
      7) On/Off Delay
      8) One Shot Falling Edge
      9) Watchdog
      10) Trigger On Delay
   h. Accuracy shall be $\pm$ 2% and repeatability shall be $\pm$ 0.1%.
   i. Furnished with integral transient protection.
   j. LED indicator light(s) for "timing" and "on/off status"
   k. Held in place with hold-down spring
   l. Equal to Square D type JCK with matching plug-in socket.

2.6. CONFORMAL COATINGS

A. All printed circuit boards within electronic devices (PLCs, RTUs, controllers, I/O modules, power supplies, touchscreens, Ethernet switches, radios, etc.) installed in panels located in non-conditioned or exterior/process areas shall be conformal-coated for harsh environments.

2.7. DC POWER SUPPLIES

A. DC Power supplies shall be provided where specified elsewhere, or as required by design of system. Power supplies shall be industrial type, AC-to-DC switching, output voltage as required, 120vac input, size as required for the initial application plus 50% spare capacity.
B. Redundant power supplies with diode isolation shall be provided so that the loss of one power supply does not affect system operation. The back-up supply systems shall be designed so that either the primary or the back-up supply can be removed, repaired, and returned to service without disrupting the system operation.
C. Power supply output shall be protected by secondary overcurrent protection device(s).
D. The power distribution from multiloop supplies shall be selectively fused so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply.
E. Each power supply shall meet the following requirements.

1. Regulation, line: 0.4% for input from 105 to 132vac.
2. Regulation, load: 0.8%
3. Ripple/Noise: 15mV RMS / 200 mV peak to peak
4. Operating temperature range: 0 deg C - 60 deg C
5. Overvoltage protection
6. Overload Protection
7. Output shall remain within regulation limits for a least 16ms after loss of AC power at full load.
8. Output status indicator.
9. UL listing

F. Power supplies shall be manufactured by Puls, Sola, Phoenix Contact or equal.

2.8. UNINTERRUPTIBLE POWER SUPPLIES

A. Uninterruptible power supplies (UPSs) shall be provided where specified elsewhere, or as required by design of system. Power supplies shall be industrial type, size as required for the initial application plus 50% spare capacity unless noted otherwise.
B. Battery runtime shall be as specified elsewhere. If no other specification for battery runtime is specified, battery runtime shall be 12.5 minutes at full load.
C. UPSs shall be double-conversion, on-line type.
D. UPSs shall be rated for operation in -20 degrees C to 55 degrees C ambient temperatures.
E. UPS batteries shall be hot-swappable and 12-year rated when installed in 25 degrees C environment and 4-year rated when installed in 50 degrees C environment.
F. UPSs shall include dry contacts for the following alarm points:
    1. Loss of Input Power Alarm
    2. Low Battery Alarm

G. UPSs shall be manufactured by Falcon UPS or approved equal.

2.9. DISCONNECTS

A. A main disconnect switch or circuit breaker shall be supplied integral to all control panels. The main disconnect or circuit breaker shall be accessible/operable without exposing the operator to energized sections of the control panel(s).
B. Individual circuit breakers shall be provided integral to the manufactured control panel for each separate power circuit originating within the control panel.
C. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.
D. Manufacturers:
    1. Square 'D' or Cutler Hammer.

2.10. COMBINATION STARTERS

A. All combination starters shall utilize a unit disconnect. Magnetic starters shall be furnished in all combination starter units unless specifically shown otherwise. All starters shall utilize full NEMA/EEMAC rated contactors (size 1 minimum).
B. Starters shall be provided with a three-pole, external (door mounted) manual reset, solid

state overload relay. Solid state overload relay shall have switch-selectable trip class and shall provide protection from:

1. Overload.
2. Phase Unbalance.
3. Phase Loss.
4. Ground Fault (Class II detection).

C. Unless specifically shown otherwise, each combination starter shall be furnished with a control circuit transformer including two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads (including motor space heaters and other similar loads where specified). The transformer rating shall be fully visible from the front when the unit door is opened. Unless otherwise indicated, control voltage shall be 120V AC. Control power shall be provided by individual unit control power transformers.

D. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.

E. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.

F. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.

G. Each starter shall be equipped with a minimum of the following control devices:

1. Door-mounted reset button.
2. Two (2) field-reversible (N.O./N.C.) auxiliary contacts
3. For reversing and two-speed starters: Four (4) field-reversible (N.O./N.C.) auxiliary contacts
4. Additional control devices as indicated on plans.

H. Control Wiring Terminal Blocks

1. Terminal blocks shall generally be:
    a. Feed-thru, screw-in type
    b. DIN rail mounted
    c. Furnished with the stationary portion of the block secured to the unit bottom plate
    d. Furnished with unit-mounted control terminal blocks for each field wire.
    e. Rated for the voltage and current of the proposed application per UL/NEC standards.
    f. Sized (by supplier) for the associated wire gauges/types/quantities.
    g. Phoenix Contact UT-4 series, Weidmuller WDU-4 series (or equivalent) unless required otherwise by application.

I. Nameplates

1. Each unit shall be properly labeled with an engraved phenolic nameplate with a white background and black letters.
2. Each pilot device shall be properly labeled with a legend plate or an engraved phenolic nameplate.

J. Manufacturers:

1. Square 'D' or Cutler Hammer.

2.11. WIRING

A. Refer to Section 26 05 19 for all wiring types/applications.
B. All wiring shall be identified on each end with hot stamped, shrink tube type, or self-laminating vinyl permanent wire markers to correspond with numbering shown on wiring diagrams.
C. All connections shall be made on terminals with no splices.
D. All wiring runs shall be along horizontal or vertical routes to present a neat appearance. Angled runs will not be acceptable. Group or bundle parallel runs of wire in plastic wire duct where practical.
E. All wiring runs shall be securely fastened to the panel or wire duct by means of plastic wire ties. Adequately support and restrain all wire runs to prevent sagging or movement.
F. AC power wiring and instrumentation/analog wiring shall be run separate.
G. Color code all internal wiring (not field wiring) as follows:
    1. Line and load circuits: Black (B)
    2. AC control wiring: Red (R)
    3. Externally-Powered control wiring: Yellow (Y)
    4. Neutral wiring: White (W)
    5. Low voltage DC(+)pos: Blue (BL)
    6. Low voltage DC(-)neg: Blue/White Tracer (BL/W)
    7. Grounding: Green (G)

H. Terminal strips shall be provided for all input and output wiring. No more than two (2) wires shall be connected to one (1) terminal block.

2.12. ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. General
    1. Function: Protect the system against damage due to electrical surges.

B. Application: As a minimum, provide surge and transient protection (with proper grounding) at the following locations as described below:
    1. Power Input High Frequency Noise Filtering:
        a. 120VAC Control panels with integral UPSs, PLCs, or other electronic/microprocessor equipment that is susceptible to failure or improper operation due to high frequency/harmonic input transients shall be provided with series-connected high-frequency noise filters on the line input (downstream of any panel main disconnects/breakers). Filters shall be as manufactured by Edco/Emerson/Islatrol or equal (exact type(s) as required by application).
    2. Power Input Surge Protection:
        a. Provide surge protection device at any connection of 120VAC power to panels containing programmable logic controllers, remote I/O equipment, UPS's, transmitters, radios, VFDs, Reduced Voltage Soft Starters or other electronic equipment. Device shall:
            1) Be mounted internal to the associated panel, with dedicated overcurrent protection.
            2) Be of two-part (base and SPD), DIN-rail mountable construction.
            3) Have 15kA total nominal discharge current per line (based on 8/20µs waveform).

4) Have maximum continuous operating voltage (MCOV) rating as required by the associated circuit voltage.
5) Visually indicate operational status.
6) Be Dehn DEHNguard series or equal by MTL Technologies, or may be combined with the High Freqency Noise Filtering device required above.

b. Provide surge protection device at any connection of multi-pole AC power to panels containing programmable logic controllers, remote I/O equipment, UPS's, transmitters, radios, VFDs, Reduced Voltage Soft Starters or other electronic equipment. Device shall:
1) Be mounted internal to the associated panel, with dedicated overcurrent protection.
2) Provide protection for all phases.
3) Have 40kA (per phase) peak surge current rating.
4) Have maximum continuous operating voltage (MCOV) rating as required by the associated circuit voltage.
5) Visually indicate operational status.
6) Be Square D SDSA or HWA series or equal.

3. Analog I/O Panel Terminations Surge Protection:
a. Provide surge protection device at the PLC (or similar) panel connection of each analog I/O signal. Device shall:
1) Be mounted internal to the associated panel.
2) Be of two-part (base and SPD), DIN-rail mountable construction.
3) Have 10kA total nominal discharge current per line (based on 8/20µs waveform).
4) Have maximum continuous operating voltage (MCOV) rating as required by the associated signal.
5) Be Dehn Blitzductor XT series or equal by MTL Technologies.

4. Discrete I/O Panel Terminations Surge Protection:
a. Provide isolation relay at the PLC (or similar) panel connection of each discrete output signal (within the associated panel). See above for isolation relay requirements.

5. Low Voltage Power Supply Load Side Surge Protection:
a. Provide surge protection device at the PLC (or similar) panel on the load side of each low voltage power supply that has low voltage connections extending external to the panel. Device shall:
1) Be mounted internal to the associated panel.
2) Be of two-part (base and SPD), DIN-rail mountable construction.
3) Have 10kA total nominal discharge current per line (based on 8/20µs waveform).
4) Have maximum continuous operating voltage (MCOV) rating as required by the associated utilization voltage.
5) Be as manufactured by Dehn, MTL Technologies, or Phoenix Contact.

6. Network Panel Terminations Surge Protection:
a. Provide surge protection device at the PLC (or similar) panel connection of each network cable. Device shall:
1) Be mounted internal to the associated panel.
2) Be of DIN-rail mountable construction.
3) Have 1kA total nominal discharge current per line (based on 8/20µs waveform).
4) Be designed specifically for the associated network connection type (Ethernet, RS485, RS232, etc.).

5) Be MTL Zonebarrier series or equal.

7. Antenna Cable Terminations Surge Protection:
   a. Provide surge protection device at the connection of antenna cable to the radio panel. Device shall:
      1) Be mounted internal to the associated panel.
      2) Provide coarse protection via replaceable gas-filled surge voltage arrestor
      3) Be Phoenix Contact COAXTRAB series or equal.

C. Installation and grounding of suppressor: As directed by manufacturer. Provide coordination and inspection of grounding.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Provide enclosure mounting supports as required for floor, frame or wall mounting. All supports in exterior, wet or process areas shall be stainless steel unless noted otherwise. All floor-mounted panels or other similar distribution equipment shall be mounted on 6” concrete housekeeping pads unless specifically shown otherwise.
B. All enclosures used outside shall be solid bottom unless otherwise specified. All cable and piping openings shall be sealed watertight. Cable and piping shall enter the enclosure as shown on drawings or specified herein.
C. All equipment and components shall be solidly grounded to the control panel. One grounded terminal unit shall be provided in each control panel for connection to plant ground system. Grounding digital and analog components shall be performed in accordance with the instrument supplier’s installation recommendations. Signal ground shall be solidly connected to the ground system so as to prevent ground loops

3.2. PAINTING

A. For enclosures other than NEMA 4X stainless steel or fiberglass:
   1. Completely clean all surfaces so that they are free of corrosive residue. Then, phosphatize all surfaces for corrosion protection.
   2. Prime with two (2) coats and finish with one coat of factory finish textured polyurethane. Paint shall be Sherwin-Williams Polane “T’ or approved equal.
   3. Color to be selected during shop drawing review phase.

3.3. IDENTIFICATION & DOCUMENTATION

A. Refer to specification section 26 05 53 for additional requirements.
B. Control panel power supply source, type, voltage, number or circuit ratings shall be identified inside control panels and on drawings.
C. All interior devices and components shall be identified with thermal transfer labels with black letters on white background. Labels shall be placed on the subpanel and not the component. Marking system shall be a Brother “PTouch II” or equal. Lettering shall be 1/4" high.
D. All front panel mounted devices such as push buttons shall be identified by the use of engraved bakelite nameplates or legend plates. Nameplates shall be 1/8” thick, white with black core.
E. Where a panel includes a PLC or other network-connected device that is intended to be connected to another system (such as a plant SCADA system) via a network

connection, the panel supplier shall provide an Interface Control Document (ICD) to the other system supplier (such as the SCADA Integrator). This document shall itemize the following for each networked parameter that is capable of being monitored or controlled by the other system:

1. Parameter Name/Function (ex: Pump No. 1 On/Off Status)
2. Parameter Type (discrete or analog, input or output)
3. Parameter register ID/location

F. Where a panel includes a touchscreen or other programmable HMI display and is to be monitored by another system (such as a plant SCADA system), the panel supplier shall provide copies of the HMI display code and screenshots of all proposed HMI screens to the other system supplier (such as the SCADA Integrator) for their use in duplicating the associated HMI.

G. A job-specific, custom wiring diagram for each control panel (not including control stations without relays) shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to the panel (whether the components are mounted internal or external to the enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated panel, and submitted to the owner with the as-built documentation.

3.4. OWNER TRAINING

A. Fully train the owner in the proper operation of all control panels/equipment, describing and demonstrating full operation, including function of each door-mounted device.

3.5. SPARE EQUIPMENT

A. Provide the following spare equipment:

1. Fuses: 10% (minimum of 3) of each size and type utilized, mounted within a pocket within the associated control panel.
2. Where control panel contains programmable controller (or similar equipment): Flash drive containing copies of all final programs utilized within the control panel, with provisions/cable assemblies as required to connect the flash drive provided to the controller to download the programs. Flash drive shall be attached to retractable cord (long enough to reach the associated port) attached to the inside of the panel door.

END OF SECTION 26 29 00

SECTION 26 29 23 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1. SCOPE OF WORK

A. This section provides specification requirements for adjustable frequency drives, variable speed drives or herein identified as VFD's.
B. The manufacturer shall furnish, field test, adjust and certify all installed VFD's for satisfactory operation.
C. Any exceptions or deviations to this specification shall be indicated in writing and submitted to the engineer for approval a minimum of ten (10) days prior to bid.

1.2. REFERENCES

A. ANSI®/NFPA® 70 - National Electrical Code® (NEC®)
B. CSA® C22.2 No. 14-M91 - Industrial Control Equipment
C. IEC 61000 - Electromagnetic Compatibility
D. NEMA 250 Enclosures for Electrical Equipment
E. NEMA ICS7 - Industrial Control and Systems Adjustable Speed Drives
F. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives
G. UL® 50 – Enclosures for Electrical Equipment
H. UL 98 – Disconnect Switches
I. UL 507 – Electric Fans
J. UL 508 – Industrial Control Equipment
K. UL 508C – Power Conversion Equipment
L. UL 991 – Safety Tests for Safety Related Controls employing Solid State Devices
M. OSHA® 1910.95 – VFD Controller Acoustical Noise

1.3. QUALITY ASSURANCE

A. The manufacturer of the VFD shall be a certified ISO 9001 facility.
B. The VFD and all associated optional equipment shall be UL Listed according to UL508C Power Conversion Equipment. A UL label shall be attached inside each enclosure as verification.
C. The VFD shall be designed constructed and tested in accordance with UL, CSA, NEMA and NEC standards.
D. Quality Assurance documentation shall be furnished to verify successful completion upon written request of the engineer.

1.4. SUBMITTALS

A. Submittals shall be furnished in accordance with Specification Section 26 05 00.
B. Provide the following for each VFD:
    1. A job-specific, custom wiring diagram
        a. The wiring diagram shall clearly show all control components connected to the starter (whether the components are mounted internal or external to the VFD enclosure).
        b. All wires and terminal blocks shall be clearly labeled.
        c. Diagram shall be in accordance with NEMA/ICS standards.

2. Size, type and rating of all system components.
3. Enclosure frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Available conduit entry and exit locations.
6. Manufacturer’s product data sheets for all components.

C. Standard catalog sheets showing voltage, horsepower, maximum current ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated VFD shall be provided.

1.5. WARRANTY

A. An 18-month parts warranty shall be provided on materials and workmanship from the date of owner acceptance/substantial completion after completion of startup.

PART 2 - PRODUCT

2.1. MANUFACTURERS

A. The VFD equipment shall be:
1. Square 'D' or Cutler Hammer.
2. Or pre-approved equal meeting the detailed requirements of this specification. Note that all “named” Manufacturers are obligated to meet the detailed requirements of this specification. Any proposed exceptions shall be clearly stated at bid time, citing the reason for noncompliance, and the cost for providing a conforming product. Failure to provide a detailed list of proposed exceptions may cause a bid to be deemed non-responsive. The Engineer will be the sole determiner of the acceptability of a proposed exception.

B. Alternate control techniques other than pulse width modulated (PWM) are not acceptable.

2.2. GENERAL DESCRIPTION

A. The VFD shall convert the input AC mains power to an adjustable frequency and voltage as defined below and indicated on the drawings or motor control schedules.
1. Where not specified otherwise, the VFD manufacturer shall use a 6-Pulse bridge rectifier design with line reactors for effective harmonic mitigation. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. The power section shall be insensitive to phase rotation of the AC line. The line reactor ratings shall be as follows, unless specified otherwise:
a. For drives without DC link chokes: 5% line reactor.
b. For drives with DC link chokes: 3% line reactor.
2. Where so specified on contract drawings, the VFD manufacturer shall supply a Low Harmonic Active-Front-End drive design equal to Square D Altivar ATV680, with the following characteristics:
a. The VFD shall be a 3-level Active Front End (AFE) AC drive that is designed to comply with standard IEEE 519-2014 when installed in a system that is already in compliance with the standard. A 3-level design shall be used to provide a low harmonic current load to the power system and to avoid introducing additional common mode noise to the motor. Passive harmonic filters shall be acceptable for motors less then 150hp in

size provided the TDD is shown to be less than limits established by IEE 519-2014. The 2-level type design shall not be acceptable due to the additional common mode noise output from the VFD to the motor. Input THDi of less than 5% at 80% load.

b. "Stop and Go" function to de-energize active front end while not in use to reduce energy consumption and to provide isolation in standby mode
c. Embedded power measurement and energy dashboard
d. Performance Drift Monitoring
e. The power section shall be insensitive to phase rotation of the AC line.

B. The output power section shall convert fixed DC voltage to adjustable frequency AC voltage. This section shall use insulated gate bipolar transistors (IGBT) or intelligent power modules (IPM) as required by the current rating of the motor.
C. The VFD shall be furnished with a long lead motor protection RCL filter system to reduce peak voltage spike conditions at the motor terminals. Filters shall be MTE Series A dV/dT Filters, TCI V1K filter or equal, with amperage rating equal to, or exceeding, that of the corresponding VFD. The exact filter type and ratings shall be selected to coordinate with the proposed VFD and the associated frequency range.

2.3. CONSTRUCTION

A. Refer to Specification Section 26 24 19 (Motor Control Centers) or Specification Section 26 29 00 (Manufactured Control Panels) as applicable for additional requirements (for enclosure, component types, etc.).
B. The VFD shall be provided complete with a main circuit breaker disconnect means for Type 1 short circuit overcurrent protection as follows:
   1. Short circuit withstand rating shall be equal to or greater than the AIC rating listed on the plans for the distribution equipment (motor control center, panelboard, switchboard, etc.) that feeds the VFD.
   2. Where the VFD installed within a motor control center, refer to Motor Control Centers Specification Section 26 24 19.
   3. Sized by manufacturer per NEC requirements for corresponding motor load.

C. A mechanical interlock shall prevent an operator from opening the VFD door when the disconnect is in the on position. Another mechanical interlock shall prevent an operator from placing the disconnect in the on position while the VFD door is open. It shall be possible for authorized personnel to defeat these interlocks.
D. Provisions shall be provided for locking all disconnects in the off position with up to three padlocks.
E. Provisions shall be made for accepting a padlock to lock the enclosure door.
F. A seismic qualification label shall be provided for all wall and floor mount units to comply with the latest IBC and NFPA 5000 guidelines.

2.4. MOTOR DATA

A. Each VFD shall be sized to operate the AC motors defined to match load schedules and other specification documents as follows:
   1. Motor Horsepower and voltage rating(s) – See electrical drawings and schedules.
   2. Minimum full load amperage rating of VFD – See electrical drawings and schedules.

3. Motor full load amperes, RPM and service factor ratings - See individual motor specification documents.

B. The VFD manufacturer shall be responsible for verifying each exact motor amperage, horsepower, voltage, RPM and service factor with motor equipment supplier prior to submitting shop drawings.

2.5. APPLICATION DATA

A. The VFD shall be sized to operate either a Variable Torque or Constant Torque load (unless specifically stated otherwise on drawings). The exact load type shall be as determined by the motor supplier and shall be coordinated by the VFD supplier prior to submitting shop drawings.
B. The speed range shall be from a minimum speed of 0.1Hertz to a maximum speed of 60 Hertz.

2.6. ENVIRONMENTAL RATINGS

A. The VFD shall meet IEC 60664-1 and NEMA ICS-1 Annex A standards.
B. The VFD itself shall be designed to operate without derating in an ambient temperature from 0 to + 40 degrees C (+32 to 104 degrees F). Where temperatures exceed these limitations, the VFD manufacturer shall properly derate the unit as required and shall clearly submit this derating calculation with the submittal package. See Specification Section 26 24 19 (Motor Control Centers) or Specification Section 26 29 00 (Manufactured Control Panels) as applicable for additional requirements (for thermal controls required within VFD outer enclosures).
C. The storage temperature range shall be -25 to +65 degrees C (-13 to +149 degrees F).
D. The maximum relative humidity shall be 95 percent at 40 degrees C non-condensing or dripping water conforming to IEC 60068-2-3.
E. The VFD shall be rated to operate at altitudes less than or equal to 3,300 feet (1000 meters) without derating. For altitudes above 3,300 feet, de-rating factors shall apply by the manufacturer.
F. The VFD shall conform to IEC 600721-3-3-3M3 amplitude for Operational Vibration Specifications.

2.7. ELECTRICAL RATINGS

A. The VFD shall be designed to operate from the rated input voltage plus or minus 10 percent.
B. The VFD shall operate from an input voltage frequency range of 57 to 63 Hertz.
C. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.
D. The efficiency of the VFD at 100 percent speed and load shall not be less than 96 percent.
E. The VFD unit amperage shall be the greater of the following:
    1. 110% of the NEC amperage rating associated with the horsepower rating shown on the plans (for constant torque loads).
    2. 100% of the unit amperage rating shown on the plans (for constant torque loads).

F. The rated VFD overcurrent capacity shall be 150 percent of the constant torque rating (or 110 percent of the variable torque rating where applicable) for one minute.
G. The VFD shall have a coordinated short circuit rating equal to or in excess of the

minimum value listed on the piece of distribution equipment that feeds the VFD. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. This rating shall be listed on the nameplate.

H. The output carrier frequency of the VFD shall be randomly modulated depending on Drive rating for low noise operation. No VFD with an operable carrier frequency above 10 kHz shall be allowed.
I. The output frequency shall be from 0.1 to 200 Hertz.
J. The VFD shall be able to develop rated motor torque at 0.5 Hertz (60 Hertz base) in a sensorless flux vector (SVC) mode using a standard induction motor without an encoder feedback signal.

2.8. PROTECTION

A. Upon power-up shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power and the pre-charge circuit.
B. Protection against short circuits, between output phases and ground; and the logic and analog outputs.
C. Minimum AC undervoltage power loss ride-through of 200 milliseconds. The VFD shall have the user-defined option of frequency fold-back to allow motor torque production to continue to increase the duration of the powerloss ride-through.
D. Selectable ride through function that shall allow the logic to maintain control for a minimum of one second without faulting.
E. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function shall provide programmable restart attempts. The programmable time delay before restart attempts shall be unlimited.
F. Deceleration mode programmable for normal and fault conditions. The stop modes shall include free-wheel stop, fast stop and DC injection braking.
G. Upon loss of the analog process follower reference signal, shall fault and/or operate at a user-defined speed set between software programmed low-speed and high-speed settings.
H. Solid state I^2t protection that is UL Listed and meets UL 508C as a Class 10 overload protection and meets IEC 60947. The minimum adjustment range shall be from 20 to 150 percent of the nominal output current rating of the VFD.
I. Thermal switch with a user selectable pre-alarm that shall provide a minimum of 60 seconds delay before overtemperature fault.
J. Use bonded fin heatsink construction for maximum heat transfer.
K. Fold-back function that shall automatically anticipate a controller overload condition and fold back the frequency to avoid a fault condition.
L. The output frequency shall be software enabled to fold back when the motor is overloaded.
M. There shall be three skip frequency ranges with hysteresis adjustment that can each be programmed independently, back to back or overlapping.

2.9. ADJUSTMENTS AND CONFIGURATIONS

A. The VFD shall self-configure to the main operating supply voltage and frequency. No operator adjustments shall be required.
B. Upon power-up, automatically send a signal to the connected motor. The stator resistance data shall be measured at rated current. The VFD shall automatically

optimize the operating characteristics according to the stored data.

C. The VFD shall be factory pre-set to operate most common applications.
D. A choice of four types of acceleration and deceleration ramps shall be available in the VFD software; linear, S curve, U curve and custom.
E. The acceleration and deceleration ramp times shall be adjustable from 0.01 to 3,200 seconds.
F. The volts per frequency ratios shall be user selectable to meet variable torque loads, normal and high-torque machine applications.
G. The exact acceleration ramp time/type, current limitation, overload protection type and motor current shall be set in the field by the startup technician prior to equipment startup as recommended/approved by the motor supplier.
H. The memory shall retain and record run status and fault type of the past eight faults.
I. Slip compensation shall be adjustable from 0 to 150%.
J. The software shall have an “Energy Saving” function that shall reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hertz ratio shall be maintained during acceleration. The output voltage shall then automatically adjust to meet the torque requirement of the load.
K. The VFD shall offer programmable DC injection braking that shall brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current shall be adjustable between 10 and 110 percent of rated current and available from 0.1 to 30 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50 percent of the nameplate current of the motor.
L. Sequencing logic shall coordinate the engage and release thresholds and time delays for the sequencing of the VFD output, mechanical actuation and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

2.10. GRAPHIC TERMINAL DISPLAY INTERFACE

A. The graphic display terminal shall provide 8 lines of 240 by 160 pixels in plain English to control, adjust and configure the VFD. All electrical values, bar charts, configuration parameters, I/O assignments, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics. There shall be a standard selection of six additional languages built-in to the operating software as standard.
B. The VFD model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall all be listed on the drive identification display as viewed on the graphic display terminal.
C. As a minimum the selectable outputs shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference and machine speed.
D. The graphic display terminal shall consist of programmable function keys. The functions shall allow both operating commands and programming options to be preset by the operator. A hardware selector switch shall allow the graphic display terminal to be locked out from unauthorized personnel.
E. The graphic display terminal shall offer a simply smart to advanced user menu consisting of parameter setting, I/O map, fault history, and drive configuration. A software lock shall limit access to the main menu.
F. The navigation wheel shall provide the ability to scroll through menus and screens, select or activate functions or increase the value of a selected parameter.
G. An escape key shall allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function shall also return to a previous

menu display.

H. A RUN key and a STOP key shall command a normal starting and stopping as programmed when the VFD is in keypad control mode. The STOP key shall be active in all control modes.
I. A user interface shall be available that is a WINDOWS® based personal computer, serial communication link or detachable graphic terminal display.
J. The keypad and all door mounted controls shall be Type 12 rated.

2.11. CONTROL

A. External pilot devices shall be able to be connected to a terminal strip for starting/stopping the VFD, speed control and displaying operating status. All control inputs and outputs shall be software assignable.
B. 2-wire or 3-wire control strategy shall be defined within the software. 2-wire control allows automatic restart of the VFD without operator intervention after a fault or loss of power. 3-wire control requires operator intervention to restart the VFD after a fault or loss of power.
C. The internal power supply shall incorporate an automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs shall be current limited and shall not be damaged if shorted or excess current is pulled. See below for external power supply requirements.
D. All logic connections shall be furnished on pull apart terminal strips.
E. There shall be (2) two software assignable analog inputs with interference filtering. The analog inputs shall be software selectable and consisting of user defined configurations: 4-20 mA or 0-10 V.
F. There shall be five software assignable logic inputs that shall be selected and assigned in the software. The selection of assignments shall consist of forward, reverse, jog, plus/minus speed (2 inputs required), setpoint memory, preset speeds (up to 8 inputs), auto/manual control, controlled stop, terminal or keypad control, output contactor when applicable (2 inputs required), motor switching, and fault reset.
G. There shall be a minimum of two (2) software assignable analog outputs with interference filtering (see plans for additional requirements). The analog outputs can be selected and assigned in the software. The analog output assignments shall be proportional to the following motor characteristics: frequency, current, power torque, voltage and thermal state. The output signal shall be user defined configurations: 4-20 mA or 0-10 V.
H. A minimum of two voltage-free Form C relay output contacts shall be provided. One of the contacts shall indicate VFD fault status. The other contact shall be user assignable. Refer to plans for additional requirements.
I. There shall be a hardware input/output extension module available that also provides interlocking and sequencing capabilities. The module shall be fully isolated and housed in a finger-safe enclosure with pull apart terminal strips. The module shall add logic inputs, analog inputs, relay outputs, and analog outputs as required by wiring diagrams shown on plans. All of the I/O shall be user assignable in the software as previously defined.
J. The VFD shall have a control power source from the 120V CPT. When an input isolation contactor is provided, the 120V CPT shall be powered from upstream of the input isolation contactor such that control power to the VFD is maintained when the input isolation contactor is opened.
K. The peripheral VFD control circuitry shall be operated at 120 Vac 60 Hz from a control power transformer included within the enclosure.
L. Operator devices shall be door mounted, functions/types as shown on drawings.

M. All operator devices shall be remote-mounted using supplied 120 Vac control logic. Clearly labeled terminals shall be provided for field installation.
N. All wiring shall be clearly identified on each end to match the wiring diagram(s) provided with the VFD.
O. Refer to Specification Section 26 24 19 (Motor Control Centers) or Specification Section 26 29 00 (Manufactured Control Panels) as applicable for all operator device and control component requirements (for pushbuttons, indicator lights, selector switches, relays, control wiring, etc).

2.12. COMMUNICATIONS

A. The VFD shall be able to be connected to communication network type(s) as indicated on plans or required by the SCADA Integrator (exact network/protocol type(s) required shall be as directed by the facility SCADA Integrator). Where no specific network connections are specified on plans or required by the SCADA Integrator, the VFD shall be provided with at least one of the following network communication options:
    a. Modbus RTU serial
    b. Ethernet TCP/IP
    c. Ethernet IP

B. The communication shall be able to provide access to the control, to the adjustment and to the supervision of the VFD.
C. No additional compensation will be granted to provide gateways, network components, etc. to properly communicate with the facility SCADA system. Equipment supplier is responsible for verifying all network connection requirements with the SCADA Integrator prior to bid.

2.13. INPUT SURGE PROTECTION

A. Each drive that does not have an upstream isolation contactor, and is not mounted within an MCC that has its own main bus surge protection shall be provided with a 3-phase, line-side surge protection device rated 80kA (per phase) or greater. The lead length between the surge protection device and the drive terminals shall be 12” or less. The surge protection device shall be designed / located / isolated such as to prevent / limit potential physical damage to other components within the enclosure if the surge protection device fails.

2.14. BYPASS CONTACTORS/STARTERS

A. Where specifically indicated on the contract drawings, a mechanically and electrically interlocked bypass contactor and bypass starter complete with a solid state overload relay shall be included to provide motor operation in the case of VFD failure. Bypass contactors (which are only used during bypass mode) may be NEMA or IEC rated. Bypass contactors shall fully isolate (on the line side and the load side) the VFD from the bypass starter.
B. Where specifically indicated on the contract drawings, a Reduced Voltage Soft Start bypass starter shall be provided for the emergency bypass mode.
C. Where a bypass is provided, the operator shall have full control of the bypass starter by operation of a VFD/BYPASS selector switch mounted to the front of the starter door.
D. Where a bypass is provided, neither starter shall be powered through the other starter (but each shall be wired to a common set of output terminals). Each starter (primary and bypass) shall have separate overload monitoring that does not cause the other

starter to fault.

E. The horsepower/amperage ratings of all bypass starters/contactors shall match that of the proposed drive.

PART 3 - EXECUTION

3.1. TESTING

A. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.
B. All subassemblies shall be inspected and/or tested for conformance to quality assurance specifications.
C. Each completed unit shall be functionally tested prior to shipment to assure conformance to the specifications.

3.2. DELIVERY, STORAGE AND HANDLING

A. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.
B. Equipment shall be stored indoors in a clean, dry environment as directed by the equipment supplier. Energize anti-condensation space heaters if so required.
    1. Verify that the location is ready to receive work and the dimensions are as indicated.
    2. Do not install VFD equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.3. INSTALLATION

A. Installation shall comply with manufacturer's instructions, drawings and recommendations.
B. A job-specific, custom wiring diagram for each VFD unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to the VFD (whether the components are mounted internal or external to the VFD enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.
C. Operations and Maintenance Manuals shall be provided to the owner for all VFD components, control wiring, etc.
D. Operations and Maintenance Manuals shall include hardcopy printouts of all device settings and programming.
E. For safety, reliability, and continuity of warranty, any modifications, alterations, etc. required to conform to the requirements of this specification shall be performed by the VFD manufacturer only. Distributor modifications, third party packaging, etc. of a manufacturer’s standard product are specifically disallowed.

3.4. START-UP AND TRAINING

A. The services of a qualified manufacturer's service representative shall be provided to install, test, and start up all VFD’s furnished under this specification. The schedule of the startup(s) shall be determined by the contractor.
B. Services shall include a minimum of eight (8) hours of field/classroom training for owner’s personnel on routine operation and maintenance of the specified units.

3.5. SPARE PARTS

A. The following spare parts shall be provided at no extra cost to the Owner:
   1. One of each type and size of control fuse.
   2. Three of each type and size of power fuse.

END OF SECTION 26 29 23

SECTION 26 32 13 - GENERATOR SETS

PART 1 - GENERAL

1.1. SCOPE

A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.
B. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.
C. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.2. CODES AND STANDARDS

A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of the latest editions of the following standards/codes where applicable:
   1. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
   2. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
   3. International Building Codes.
   4. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
   5. NFPA99 – Essential Electrical Systems for Health Care Facilities.
   6. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

B. The generator set and supplied accessories shall meet the requirements of the latest editions of the following standards where applicable:
   1. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
   2. UL142 – Sub-base Tanks
   3. UL1236 – Battery Chargers
   4. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

C. The generator set and supplied accessories shall meet all applicable Environmental Protection Agency (EPA) TIER Emission Level or Emission Certification requirements and any local requirements in effect at the time the generator set is ordered (for the proposed location of the generator).
D. The control system for the generator set shall comply with the following requirements.
   1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.

2. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
4. FCC Part 15, Subpart B.
5. IEC8528 part 4. Control Systems for Generator Sets
6. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
7. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
8. UL1236 –Battery Chargers.

E. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.3. ACCEPTABLE MANUFACTURERS

A. Caterpillar
B. Cummins/Onan

PART 2 - PRODUCTS

2.1. GENERATOR SET

A. General
1. The generator systems are part of a paralleling system. Paralleling switchgear for this system shall be provided by the generator supplier. Generator supplier shall provide all options/accessories/provisions/configuration/etc. as required for a complete/fully-functional paralleling system. Refer to Paralleling Switchgear specification section 26 23 00 for additional system requirements.

B. Ratings
1. The generator set assembly (including both the motor/engine assembly and the generator assembly) shall operate at 1800 rpm, and the generator shall produce a 60 Hz waveform.
2. Voltage and phase ratings shall be as shown on plans.
3. Minimum kW rating (and associated alternator sizing) shall be the greater of the following:
a. Minimum kW rating listed on plans.
b. Ratings required to provide skVA as follows (shall be documented with reports in submittals using generator sizing software described in Part 3 below):
1) If so listed on plans, the step loads fed by the generator at voltage/frequency dip criteria specified.
2) If so listed on plans, the skVA rating specified.
3) If neither of the above are listed on plans, generator shall be sized to accommodate a block load of 100% of the Total Demand Load listed on plans, with a maximum voltage dip of 20% and a maximum frequency dip of 10%.
4. kVA rating shall be 1.25 times the kW rating (based on .8 PF).

5. Unless shown otherwise on plans, the generator set shall be rated based on the following site conditions:
   a. Altitude of project site.
   b. Ambient temperatures up to 120 degrees F.
6. The generator set rating shall be based on emergency/standby service unless noted otherwise.

C. Performance
1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The engine-generator set shall be capable of accepting a single step load of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Minimum motor starting capability shall be as shown on plans. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified skVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 20% unless shown otherwise on plans.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.
6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.
7. The generator set shall share real and reactive load proportionally within plus or minus 3% with all other generator sets in the system.
8. The time required to automatically start, accelerate to rated speed and voltage, and synchronize all generator sets to the system bus on a normal power failure shall not exceed 15 seconds under normal power failure conditions (first generator shall begin suppling emergency power within 10 seconds of normal power failure per Life Safety Code requirements).

D. Construction
1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. The engine-generator set shall be rated for the seismic conditions for the installation location as mapped by the US Geological Survey and required by local building codes.
3. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

E. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept compression terminations of the number and size as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required overcurrent protection located at panelboard(s) external to the generator set unless shown otherwise on plans. Where a load center or panelboard is shown within the generator enclosure on the plans, this load center/panelboard shall be furnished with the generator and shall comply with the applicable panelboard and identification sections of this specification.
3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

2.2. ENGINE AND ENGINE EQUIPMENT

A. The engine shall be diesel, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:
   1. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed and operating in various isochronous or parallel states. The governing system shall include a programmable warm up at idle and cooldown at idle function. While operating in idle state, the control system shall disable the alternator excitation system.
   2. Skid-mounted radiator and cooling system rated for full load operation in 120 degrees F (49 degrees C) ambient as measured at the generator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H_2O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.
   3. Electric starter(s) capable of three complete cranking cycles without overheating.
   4. Positive displacement, mechanical, full pressure, lubrication oil pump.
   5. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
   6. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
   7. Replaceable dry element air cleaner with restriction indicator.
   8. Flexible supply and return fuel lines.
   9. Engine mounted battery charging alternator and solid-state voltage regulator.
   10. Block heater

a. Engine mounted, thermostatically controlled, block heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
b. The block heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The block heater installation shall be specifically designed to provide proper venting of the system. The block heaters shall be installed using quick disconnect couplers to isolate the heaters for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
c. The block heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the block heater system.
d. The block heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification. If the heater quantities or wattage ratings are different than shown on plans, contractor shall be responsible for providing the properly-rated circuits (with circuit breakers) as required to the heater(s).

11. Provide vibration isolators, spring & pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
12. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.
13. Provide critical-grade exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
14. A UL listed/CSA certified voltage regulated battery charger shall be provided for each engine-generator set. The charger shall be located at the generator unless shown otherwise on plans. Output amperage, Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
    a. Loss of AC power - red light
    b. Low battery voltage - red light
    c. High battery voltage - red light
    d. Power ON - green light and N.O. relay contact

2.3. FUEL TANK

A. Refer to "Sub-Base Fuel Tank" Paragraph below for fuel tank requirements.

2.4. AC GENERATOR

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.
B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
D. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

2.5. GENERATOR SET CONTROL

A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
B. The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
C. The generator set mounted control shall include the following features and functions:
    1. Control Switches
        a. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
        b. The integrity of the generator remote start circuit shall be monitored for broken, disconnected or shorted wires. Loss of integrity shall start the generator.
        c. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
        d. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
        e. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
    2. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:

a. Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
b. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
c. The control system shall log total number of operating hours, total kWH, and total control on hours, as well as total values since reset.

3. Generator Set Alarm and Status Display.
   a. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright exterior day lighting conditions.
   b. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:
      1) low oil pressure (warning)
      2) low oil pressure (shutdown)
      3) oil pressure sender failure (warning)
      4) low coolant temperature (warning)
      5) high coolant temperature (warning)
      6) high coolant temperature (shutdown)
      7) high oil temperature (warning)
      8) engine temperature sender failure (warning)
      9) low coolant level (warning or shutdown - selectable)
      10) fail to crank (shutdown)
      11) fail to start/overcrank (shutdown)
      12) overspeed (shutdown)
      13) low DC voltage (warning)
      14) high DC voltage (warning)
      15) weak battery (warning)
      16) low fuel (warning)
      17) high AC voltage (shutdown)
      18) low AC voltage (shutdown)
      19) under frequency (shutdown)
      20) over current (warning)
      21) over current (shutdown)
      22) short circuit (shutdown)
      23) ground fault (warning) (if genset breaker is rated 1000A or greater)
      24) over load (warning)
      25) Genset circuit breaker tripped (warning)
      26) emergency stop (shutdown)
      27) Provisions shall be made for indication of four (4) customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions.
4. Engine Status Monitoring.

a. The following information shall be available from a digital status panel on the generator set control :
    1) engine oil pressure (psi or kPA)
    2) engine coolant temperature (degrees F or C)
    3) battery voltage (DC volts)
    4) engine oil temperature (degrees F or C)
    5) engine speed (rpm)
    6) number of hours of operation (hours)
    7) number of start attempts
b. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

5. Engine Control Functions.
    a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
    b. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
    c. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
    d. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
    e. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
    f. The control system shall include all interfaces necessary for proper operation with the paralleling equipment provided under this contract. The generator set supplier shall be responsible for complete compliance to all specification requirements for both the generator set and the paralleling equipment.
6. Alternator Control Functions:
    a. The generator set shall include an automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall

include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, with local indication of setting level.

b. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

c. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445. This protection may be provided using a microprocessor-based programmable relay system designed to protect the alternator system from damage, or using programmable electronic-trip LSI breaker(s), programmed/set by the generator supplier to ensure full protection of the alternator system.

d. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

e. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

f. When required by National Electrical Code or indicated on project drawings, the control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.

g. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

7. Other Control Functions

a. The generator set shall be provided with a network communication module to allow network communication with the generator set control by remote devices. The control shall communicate all engine and alternator data, and allow starting and stopping of the generator set via the network in both test and emergency modes.

b. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is out of acceptable limits. During engine cranking (starter engaged), the low voltage limit shall be disabled,

and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

8. Dry Contacts/Relays for Remote Monitoring:
   a. The control system shall provide ten (10) programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. Five (5) of these relays shall be preconfigured (and labeled accordingly) to indicate:
      1) generator set operating at rated voltage and frequency
      2) common warning
      3) common shutdown
      4) load shed command and
      5) low fuel warning.
   b. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

2.6. GENERATOR REMOTE MANUAL STOP STATION

A. Each generator set shall be furnished with a remote manual stop station of a type to prevent inadvertent or unintentional operation per NFPA 110 requirements.
B. Stop station pushbutton shall be red, non-illuminated, push-pull, mushroom-type, maintained-contact, 1 5/8" diameter, 30mm base, heavy-duty, oil-tight, water-tight unit) mounted within guarded enclosure to prevent inadvertent operation and labeled with engraved nameplate (white letters on red background) to read: "GENERATOR EMERGENCY STOP" (or similar with specific generator name where so identified on drawings).
C. Exact stop station type shall be coordinated with generator controls supplier to ensure a fully-functional system per NFPA 110 requirements.

2.7. GENERATOR MAIN LINE CIRCUIT BREAKER(S)

A. The generator set shall be provided with a mounted main line circuit breaker(s), sized as shown on plans. The circuit breaker(s) shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.
B. The main line circuit breaker(s) shall be provided with auxiliary contacts to indicate trip/off alarm conditions to the generator set control system.

2.8. OUTDOOR WEATHER-PROTECTIVE ENCLOSURE

A. The generator set shall be provided with a weatherproof, sound-attenuated, outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank (if applicable) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service.

Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

B. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 76 dBA (including exhaust noise) at any location 7 meters from the generator set in a free field environment:

C. The enclosure shall include vertical air discharge hoods as required to redirect discharge air upwards and reduce noise accordingly.

D. The enclosure shall be insulated with non-hydroscopic materials.

E. The enclosure shall be rated for the wind and seismic conditions for the installation location as mapped by the US Geological Survey and required by local building codes.

F. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
   1. Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.
   2. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.
   3. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
   4. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
   5. Salt Spray, per ASTM B117-90, 1000+ hours.
   6. Humidity, per ASTM D2247-92, 1000+ hours.
   7. Water Soak, per ASTM D2247-92, 1000+ hours.

G. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

H. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.

I. A factory-mounted critical exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.

J. The enclosure shall include the following maintenance provisions:
   1. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
   2. External radiator fill provision.

K. If so shown on the plans, provide a factory-mounted and wired electrical distribution panel to serve the generator set and enclosure. The provisions required include:
   1. 100-amp distribution panelboard installed inside enclosure and fed by a 120/208VAC power feeder installed by the contractor (unless shown otherwise on plans).
   2. Two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure (all factory-wired).
   3. Two three-way switches controlling three AC lamps mounted in vapor tight and gasketted fixtures (all factory-wired).
   4. Factory-wired normal AC service from the panelboard to the engine coolant and alternator heaters, and battery charger.

2.9. SUB-BASE FUEL TANK

A. Provide a sub-base fuel tank for the generator set, sized to allow for full load operation of the generator set for 24 hours. The sub-base fuel tank shall be UL142 listed and labeled. Installation shall be in compliance to NFPA37. The fuel tank shall be a double-walled, steel construction and include the following features:
   1. Emergency tank and basin vents.
   2. Mechanical level gauge.
   3. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.
   4. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
   5. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level
   6. Basin drain.
   7. Integral lifting provisions.

B. The equipment, as installed, shall meet all local and regional requirements for above ground tanks.

C. Where the generator design/layout, sub-base fuel tank height, and/or concrete housekeeping pad for the generator set causes any circuit breaker handle, control device, metering display or other similar item to be located higher than 6'-7" above finished floor, the supplier shall provide an aluminum grating platform complete with stairs and handrails meeting all applicable code requirements for proper access to these items. The platform and stairs shall be permanently mounted to a concrete base as recommended by the system supplier. Alternatively, the supplier may relocate (at the factory) these items to be below 6'-7" above finished floor.

2.10. SEQUENCE OF OPERATION

A. The maximum elapsed time allowed from loss of normal power to restoration of power to emergency circuits from generator through transfer switch shall be 10 seconds.

B. Generator set shall start upon receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.
   1. The integrity of the generator remote start circuit shall be monitored for broken, disconnected or shorted wires. Loss of integrity shall start the generator.

C. The generator set shall complete a time delay start period as programmed into the control.

D. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
   1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate "fail to crank" shutdown.
   2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate "fail to start".

3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
4. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand or load govern state.

E. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
F. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
G. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

PART 3 - EXECUTION

3.1. SUBMITTALS.

A. Within 10 days after award of contract, provide six sets of the following information for review:
1. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.
2. A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
3. Manufacturer's certification of prototype testing.
4. Manufacturer's published warranty documents.
5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
7. Generator sizing software report(s) showing compliance with all specification requirements and any additional motor starting requirements indicated in contract documents.
8. Time-current-curves demonstrating that the generator alternator relaying or breaker protective device(s) provide proper protection for the alternator by a comparison of the trip characteristic of the breaker with the thermal damage characteristic of the alternator.
9. Manufacturer's installation instructions.

3.2. FACTORY TESTING.

A. The generator set supplier shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.
B. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks notice for testing.
C. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor

will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

3.3. INSTALLATION

A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
B. Installation of equipment shall include furnishing and installing all interconnecting wiring, fuel lines, etc. between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
C. Generator equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.
D. Remote stop station type, labeling and location shall be submitted by contractor to engineer and local fire marshal for approval prior to rough-in. Location shall be outside the room housing the prime mover (where so installed within a room) or elsewhere on the premises where the prime mover is located outside the building. Contractor shall provide all interconnections from remote stop station to generator set as required by generator set supplier for a fully-functional system.
E. Equipment shall be initially started and operated by representatives of the manufacturer.
F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

3.4. ON-SITE ACCEPTANCE TEST:

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
B. Installation acceptance tests to be conducted on-site shall include the following (performed in accordance with NFPA 110):
    1. "Cold start" test.
    2. Four (4) hour full load test. Provide resistive load banks and make temporary connections as required.
    3. One step rated load pickup test.
    4. Power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

C. Upon completion of the manufacturer’s site start-up and checkout, the contractor shall leave the diesel tank half full of fuel for use by the owner.

3.5. TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to not less than 5 persons. Training date shall be coordinated with the facility owner.

3.6. SERVICE AND SUPPORT

A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
B. The generator set shall be distributed and serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
C. The manufacturer of the generator set shall own, maintain and make available (to engineer, free of charge) generator set sizing software that calculates voltage dip, frequency dip, THDI and THDV of proposed generator/alternator set using the following inputs:
    1. Summary of step loads including load type (across-the-line motor, VFD, Fire Pump, Fluorescent Lighting, UPS, etc.).
    2. Generator Set Duty (Standby, Prime, Continuous).
    3. Maximum Ambient Temperature.
    4. Project site altitude.
    5. Generator Fuel type.
    6. Voltage/Phase/Frequency.

D. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.7. WARRANTY

A. The generator set and associated equipment shall be warranted for a period of not less than 2 years from the date of commissioning against defects in materials and workmanship.
B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 26 32 13

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1. SCOPE

A. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: voltage sensors on all phases of both sources, power switch mechanism, permanently attached manual operation provisions, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.

B. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided. Technicians specifically trained to support the product shall service the transfer switches.

1.2. CODES AND STANDARDS

A. The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:
   1. CSA 282, Emergency Electrical Power Supply for Buildings
   2. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
   3. NFPA99 – Essential Electrical Systems for Health Care Facilities
   4. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
   5. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
   6. NEMA ICS10-1993 – AC Automatic Transfer Switches.

B. The transfer switch assembly shall comply with the following standards:
   1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
   2. EN55011, Class B Radiated Emissions
   3. EN55011, Class B Conducted Emissions
   4. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity.
   5. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
   6. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
   7. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
   8. IEC 1000-4-6 Conducted Field Immunity
   9. IEC 1000-4-11 Voltage Dip Immunity.
   10. IEEE 62.41, AC Voltage Surge Immunity.
   11. IEEE 62.45, AC Voltage Surge.
   12. UL1008 – Transfer Switches. Transfer switches shall be UL1008 (latest edition) listed. UL1008 transfer switches may be supplied in UL891 enclosures if necessary to meet the physical requirements of the project.

C. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.3. ACCEPTABLE MANUFACTURERS

A. Cummins/Onan
B. Caterpillar
C. Zenith
D. ASCO
E. Eaton

PART 2 - PRODUCTS

2.1. POWER TRANSFER SWITCH

A. Ratings
   1. Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, voltage and ampere ratings, enclosure type, and accessories.
   2. Main contacts shall be rated for 600 Volts AC minimum.
   3. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
   4. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes equal to or greater than the required ratings shown on the drawings (at the specified voltage). The transfer switch shall be third party listed and labeled for use with the specific protective device(s) (both normal and emergency) installed in the application. All rating information including associated overcurrent devices shall be submitted with shop drawings. Where WCR is dependent on setting of upstream overcurrent device, transfer switch shall be field marked with the required settings of the associated device. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. The transfer switch and its upstream protection shall be coordinated.

B. Construction
   1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
   2. Transfer switches shall be of the Programmed (Delayed) Transition type. Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick break, quick make over center contact mechanisms. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de energized conditions.
   3. The switch shall completely disconnect the load from both sources for an adjustable period of time to allow regenerative voltage to decay to a safe level prior to connecting to the new source.
   4. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
   5. All wiring shall be UL listed 105 degree C, 600 volt rated, and sized as required. Each wire, device or function shall be identified with a source and destination by silk-screen or similar permanent identification. Circuit boards shall be connected

wiring harnesses by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.

6. Bus structures shall be constructed from silver plated copper or tin plated aluminum with bolted joints for all three phases, with a full neutral, and a 1/4 x 2 inch ground bus extending through all sections.
7. The framework and all other sheet metal components of the system shall be primed with a rust-inhibiting primer, and finished with two coats of satin finish ANSI 61 gray enamel, or manufacturer's standard color.
8. All door mounted control components shall be industrial type oil-tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty and durability control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.
9. Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation or shall be indicated by mechanical flags. Barriers shall be provided to prevent inadvertent contact with any voltage of greater than 50VDC.
10. Transfer switches shall be 3-pole with a solid neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

C. Connections
   1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
   2. Transfer switch shall be provided with AL/CU compression lugs suitable for the quantities and sizes of power conductors required.

2.2. TRANSFER SWITCH CONTROL

A. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.
   1. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
   2. High intensity LED lamps to indicate that the transfer switch is "not in auto" (due to control being disabled or due to bypass switch (when used) enabled or in operation) and "Test/Exercise Active" to indicate that the control system is testing or exercising the generator set.
   3. "OVERRIDE" pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
   4. "TEST" pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
   5. "RESET/LAMP TEST" pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
   6. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred,

and the total number of times each source has failed. This information shall be available via an operator display panel.

7. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
    a. Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance. Line to neutral voltages shall be displayed for 4-wire systems.
    b. Display source status, to indicate source is connected or not connected.
    c. The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
        1) Set nominal voltage and frequency for the transfer switch.
        2) Adjust voltage and frequency sensor operation set points.
        3) Set up time clock functions.
        4) Set up load sequence functions.
        5) Enable or disable control functions in the transfer switch, including program transition.
        6) Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
    d. Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall be incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
    e. Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
    f. Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.

B. Internal Controls
    1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
    2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
        a. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).

b. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
c. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
d. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
e. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
f. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
g. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.

3. The transfer control shall incorporate a series of diagnostic LED lamps.
4. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature. The program/delayed transition time setting (time in which load is not connected to either source during transfer) shall be initially set at 10 seconds to allow motors to properly decay per MG-1 standard
5. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).
6. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
7. The control system shall be designed and prototype tested for operation in ambient temperatures from -40C to +70C. It shall be designed and tested to comply with the requirements of the noted voltage surge and RFI/EMI standards.
8. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
9. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational. The battery power supply shall be monitored for proper condition, and the transfer switch shall include an alarm condition to indicate low battery condition.

C. Control Interface
1. The transfer switch shall provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.
2. The integrity of the generator remote start circuit shall be monitored for broken, disconnected or shorted wires. Loss of integrity shall start the generator.
3. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

4. The transfer switch shall provide additional relay contacts to indicate the following conditions: Utility Source Available, Load Connected to Utility, Generator Source Available, Load Connected to Generator, Pre-Transfer Warning (adjustable 0-59 second time delay).
5. The transfer switch shall be provided with a network communication card, and configured to allow LonMark compliant communication with the transfer switch and other network system components. The network shall provide a redundant start signal to the generator set(s) in the system.

2.3. ENCLOSURE

A. Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70. The cabinet door shall include permanently mounted key type latches.
B. If not specifically indicated otherwise on plans, transfer switch equipment enclosures shall meet the following minimum requirements:
   1. For dry interior locations: NEMA 1 or better (unless shown otherwise on plans).
   2. For wet interior (pump stations, etc.) or exterior locations: NEMA 3R or better (unless shown otherwise on plans).

C. The cabinet shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.
D. Note size and access requirements for the transfer switch (and associated equipment) and provide equipment that will fit into the space allowed and comply with code-specified access requirements.

2.4. BATTERY CHARGING

A. The transfer switch/generator set combination shall be provided with a battery charger for the generator set starting batteries. Refer to Generator Sets Specification Section 26 32 13 for specific requirements. Supply power failed indication shall be displayed on the ATS control panel.

2.5. SEQUENCE OF OPERATION

A. Programmed (Delayed) Transition Sequence of Operation
   1. Normal State:
      a. Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is connected to source 1 (connected to the utility), and no start signal is supplied to the genset.
   2. Normal Power Failure and Restoration:
      a. When the transfer switch senses a power failure on source 1, it shall complete a pre-programmed time delay start sequence, and then send a start signal to the generator set.
      b. The generator set shall immediately start and accelerate to rated voltage and frequency.

c. The transfer system shall complete a programmable time delay sequence, and then transfer to source 2 by delayed (programmed) transition. The transfer switch shall accomplish this by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later (to allow motor loads to decay per NEMA MG-1 standard).
d. On return of source 1 to acceptable voltage and frequency levels, the control system shall initiate a time delay retransfer sequence. On completion of the time delay sequence, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later (to allow motor loads to decay per NEMA MG-1 standard). The timing sequence for the contact operation shall be programmable in the controller. The control system shall transfer loads back to source 1 in the reverse sequence to that which was used to connect loads to source 2.
e. If the generator set fails during this period and normal source is available, the transfer switch shall automatically reconnect the system loads to the normal service.
f. The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set.

3. Generator Set Exercise (Test) With Load Mode (Programmed (Delayed) Transition). The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
   a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
   b. The transfer switch shall issue a compatible start command to the generator set as follows:
      1) On generators rated 50kW and greater, the transfer switch shall cause the generator set to start and run at idle until it has reached normal operating temperature. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.
      2) On generators rated less than 50kW, the generator set shall immediately start and accelerate to rated voltage and frequency.
   c. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later (to allow motor loads to decay per NEMA MG-1 standard). The timing sequence for the contact operation shall be programmable in the controller.
   d. The generator set shall operate connected to the load for the duration of the exercise period.
   e. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later (to allow motor loads to decay per NEMA MG-1 standard). The timing sequence for the contact operation shall be programmable in the controller.
   f. The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set.

g. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.
h. If the generator set fails during the exercise period and normal source is available, the transfer switch shall automatically reconnect the system loads to the normal service.

4. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:
   a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
   b. The transfer switch shall issue a compatible start command to the generator set as follows:
      1) On generators rated 50kW and greater, the transfer switch shall cause the generator set to start and run at idle until it has reached normal operating temperature. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.
      2) On generators rated less than 50kW, the generator set shall immediately start and accelerate to rated voltage and frequency.
   c. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
   d. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

PART 3 - EXECUTION

3.1. FACTORY TESTING

A. The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be submitted. Test process shall include calibration of voltage sensors.

3.2. SERVICE AND SUPPORT

A. The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
B. The transfer switch shall be serviced by a local service organization that is trained and factory certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
C. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.
D. After generator set installation, the generator set supplier shall conduct a complete operation, basic maintenance, and emergency service seminar for up to 5 persons

employed by the facility owner. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures. The class duration shall be at least 4 hours in length, and include practical operation with the installed equipment.

3.3. WARRANTY

A. The automatic transfer equipment shall be warranted (by the generator supplier when a generator is supplied within the project) for a period of not less than 2 years from the date of commissioning against defects in materials and workmanship.
B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 26 36 23

SECTION 26 41 00 - LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1. SCOPE

A. Furnish and install all materials and labor required to provide a complete and functional Lightning Protection and Common Grounding System as indicated, in strict accordance with this section of the Specifications and the applicable Contract Drawings.

1.2. STANDARDS & QUALITY ASSURANCE

A. The lightning protection system shall comply with all requirements of the latest edition of each of the following codes and standards. The latest edition of these codes and standards form a part of this specification:
   1. U.L. Standard 96A.
   2. Lightning Protection Institute - Installation Code LPI-175.
   3. N.F.P.A. 780.

B. Equipment manufacturer shall be certified by the Lightning Protection Institute, and products approved for UL listing. All materials shall be manufactured by one of the following manufacturers:
   1. Bonded Lightning Protection Systems
   2. East Coast Lightning Protection
   3. Erico/Eritech Lightning Protection
   4. Harger Lightning Protection
   5. Preferred Lightning Protection
   6. Robbins Lightning
   7. Thompson Lightning Protection

C. For approval of LPI manufacturer other than specified, complete proposed material data and installation drawings shall be submitted to Engineer for review not less than 10 days prior to bid date.

D. In order to insure integrity of installation, the system shall be installed under the direct jobsite supervision of a Certified Master Installer/Designer, who has qualified under the LPI's Certification Program as a Master Installer/Designer.

1.3. SUBMITTALS

A. Complete shop drawings of the entire lightning protection system showing the type, size, mounting details, and location of all equipment, grounds, cable routings, roof materials (for coordination of lightning protection system materials), etc., shall be submitted to the Architect-Engineer for approval prior to start of work.

B. Submittals shall document the local manufacturer’s representative’s Certified Master Installer/Designer qualifications from LPI.

PART 2 - PRODUCTS

2.1. SYSTEM

A. System materials in general shall be copper, copper alloy or aluminum with high-copper content bronze castings or aluminum castings (all compatible with associated surface materials and installed per UL, NFPA & LPI standards), and shall comply in weight, size and composition for the class of structure to be protected. The system shall consist of all necessary cables, air terminals, mounting bases, fittings, couplings, connectors, fasteners, surge protection devices, etc., as required to give a complete and coordinated system.
B. Copper conductors shall be utilized for all downleads and below-grade conductors.
C. Aluminum components shall be utilized in cases where copper is not compatible with mounting surfaces.
D. All ground rods shall be copper-clad steel.
E. All cable and all air terminals shall bear proper UL labels.
F. Air terminals shall have blunt tips.
G. System design shall be concealed wherever practical, with roof perimeter cables concealed in parapet walls, and mid-roof cables installed under roof slabs. Exposed cable on parapet walls will only be accepted if structural details preclude cable concealment. Cable drops for roof penetrations at downlead locations shall be made with solid-bar thru-roof connectors, with copper rod flashings. Bond rebars top and bottom at each downlead position and risers. Primary and secondary bonding of roof metals and equipment shall also be under roof slabs. Ground level, intermediate and roof level potential equalization shall be provided per current building Code classifications.
H. All system fittings except cable holders, regardless of Structure classification, shall be heavy-duty type made from bronze or aluminum castings and secured with bolted-pressure clamps. Pressure plates made from stamped or pressed metal parts, or fittings utilizing crimp-type pressure devices will not be allowed. All bolts, screws, and related type hardware shall be stainless steel.
I. Contractor shall coordinate with the roofing contractor to insure compatibility of any adhesive with the roofing system in use.
J. Cable fasteners shall be substantial in construction, electrolytically compatible with the conductor and mounting surface, and shall be spaced according to LPI, UL, and NFPA code requirements.
K. Where applicable, an approved bimetal transition fitting shall be used at the roof level to change from aluminum roof conductor to copper downlead cable.
L. Surge protection devices shall be provided on the power, telecommunications and other conductive electrical services at the points of entrance into the building(s) as required by UL96A in order to obtain the UL Master Label Certificate of Inspection. It shall be the responsibility of the electrical contractor to install or verify that a proper surge protection device has been installed on the each of the building electrical services to meet this requirement. This may require surge protection devices in addition to those specifically shown on plans or called out within other specifications.

PART 3 - EXECUTION

3.1. SUPERVISION AND CERTIFICATION

A. The manufacturer's local representative shall be a Certified Master Installer/Designer under the LPI program, and shall provide direct jobsite technical supervision to Contractor's personnel during installation to insure compliance with all Code requirements. Upon job completion, Contractors shall furnish Owners with written certification on UL Master Label "C",that system is installed in compliance with above Standards.

END OF SECTION 26 41 00

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES

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 field-mounted SPDs for low-voltage (<1000 V) power distribution and control equipment.
B. The specified unit(s) shall provide effective high energy transient voltage surge suppression, surge current diversion and high frequency noise attenuation in all electrical modes for equipment connected downstream from the facility's meter or load side of the main overcurrent device. The unit(s) shall be connected in parallel with the facility's wiring system.
C. The unit(s) shall be designed and manufactured in North America by a qualified manufacturer of suppression filter system equipment. The qualified manufacturer shall have been engaged in the commercial design and manufacturer of such products for minimum of ten (10) years.
D. All products that are submitted according to these specification will be required to meet this specification in it's entirety for both service and distribution TVSS systems. Any product that is submitted and does not comply with all parts of this specification will be subject to rejection.

1.3. DEFINITIONS

A. VPR: Voltage Protection Rating.
B. SPD: Surge Protective Device(s)
C. $I_{(n)}$: Nominal Discharge Current

1.4. SUBMITTALS

A. See specification section 26 05 00.
B. Product Data: For each type of product indicated. Include:
    1. Maximum Single Impulse Surge Current Rating.
    2. Surge Life (Repetitive Surge) Rating.
    3. UL1449 (Latest Edition) Voltage Protection Ratings (VPR).
    4. UL1449 (Latest Edition) Nominal Discharge Current (In).
    5. Product dimensions and weights.
    6. Furnished specialties and accessories.

C. Qualification Data:
D. Safety Agency File Number.
E. ISO 9001-2008 Certification.
F. ISO 1401-2001 Certification.
G. Operation and Maintenance Data: For SPDs to include all submittal data and any applicable operation and maintenance manuals.
H. Warranties: Sample of special warranties.

1.5. QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
B. The unit shall be UL 1449 Listed and CUL Approved as a Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference Filter
C. Provide 2nd party certified data demonstrating SPD response to ANSI/IEEE C62.41.2-2002 standard waveforms when tested according to IEEE C62.45.
D. Comply with NFPA 70.
E. All SPDs provided within this project at the service entrance, distribution panels, and sub-panels shall be from the same manufacturer.

1.6. PROJECT CONDITIONS

A. Service Conditions: Rate SPDs for continuous operation under the following conditions unless otherwise indicated:
   1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
   2. Operating Temperature: 30 to 150 deg F.
   3. Humidity: 0 to 95 percent, non-condensing.
   4. Altitude: Less than 13,000 feet above sea level.

1.7. COORDINATION

A. Where field-mounted SPD's are specifically shown on plans, coordinate locations of field-mounted SPDs to allow adequate clearances for maintenance.

1.8. WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

1.9. EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Replaceable Protection Modules: 1 of each size and type installed, where field-replaceable modular SPDs are provided.
   2. Fuses: 1 of each size and type installed, where field-replaceable fuses are provided.

PART 2 - PRODUCTS

2.1. SURGE PROTECTIVE DEVICES

A. Manufacturer:
   1. Integral Devices: Surge Protective Devices shall be as manufactured by the distribution equipment manufacturer (Square D, etc.), or by Surge Suppression Inc. if all of the performance of this specification are met and all UL listing of the equipment manufacturer are met.

2. External Devices (where specifically specified on plans): Surge Protective Devices shall be as manufactured by the distribution equipment manufacturer (Square D, etc.) or Surge Suppression Inc.

B. Each Surge Protective Device shall:
   1. Be internal to the associated distribution equipment (without violating any applicable UL listings) unless specifically shown otherwise on plans.
   2. Be UL 1449 (Latest Edition) listed.
   3. Have short-circuit current rating complying with UL 1449 (Latest Edition), that matches or exceeds the short-circuit rating of the associated distribution equipment.
   4. Be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
   5. Have fuses, rated at 200-kA interrupting capacity.
   6. Have a minimum UL 1449 Nominal Discharge Current (I_n) Rating of 20kA.
   7. Be fabricated using bolted compression lugs.
   8. Provide suppression for all ten (10) modes of protection.
   9. Have LED indicator lights for power and protection status of each phase.
   10. Have audible alarm, with silencing switch, to indicate when protection has failed.
   11. Have form-C contacts rated at 2 A and 24-V ac minimum, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with facility monitoring and control system if monitoring by that system is required by plans or other specifications.
   12. Have six-digit transient-event counter, mounted to front of equipment door, set to totalize transient surges (externally mounted SPD's may have the transient – event counter monted on the visible face of the SPD).
   13. Meet all UL 96A requirements (for Lightning Protection Systems) where the device is installed at a service entrance of the facility. At a minimum, these devices shall:
      a. Be marked as Type 1 or Type 2 SPDs with product Identity consisting of "Surge Protective Device" or "SPD", and identifying all ratings so required by UL96A and the 4 digit alpha numeric Control Number.
      b. Have a minimum UL 1449 Nominal Discharge Current (I_n) Rating of 20kA.
      c. Be UL listed and labeled with holographic label.

C. Peak Single-Impulse Surge Current Rating shall be meet the following minimums unless specifically shown otherwise on plans:

Application	**Per Phase**	**Per Mode**
Service Entrance Devices	240 kA	120 kA
Downstream Devices	160 kA	80 kA

D. The ANSI/UL 1449 voltage protection rating (VPR) in grounded wye circuits, the SPDs shall not exceed the following:

Modes	**208Y/120V**	**480Y/277V**	**600Y/347V**

L-N,L-G, N-G	800	1200	1500
L-L	1200	2000	2500

E. The ANSI /UL 1449 VPR for 240/120 V, 3-wire or 4-wire circuits with high leg shall not exceed the following:

Modes	**240/120V**
L-N,L-G, N-G	1200/800

2.2. ENCLOSURES

A. Where external units are specifically specified on plans, units not mounted within electrical distribution equipment (such as switchboards, MCC's, etc.) shall be provided in enclosures with NEMA enclosure ratings that match or exceed the NEMA enclosure ratings of the equipment from which the units are fed. For example, a unit fed from a NEMA 4X stainless steel panelboard shall also be mounted within a NEMA 4X stainless steel enclosure.

PART 3 - EXECUTION

3.1. INSTALLATION

A. All SPD's shall be integrally-mounted within the associated distribution equipment unless specifically shown otherwise on plans.
B. Install SPDs at service entrance on load side, with ground lead bonded to service entrance ground.
C. Install SPDs downstream of the service entrance with conductors or buses between suppressor and points of attachment as short and straight as possible. The lead lengths between the TVSS unit and the equipment being protected shall not exceed fourteen (14) inches without approval from the engineer. Do not bond neutral and ground. Leads shall be as straight as possible with no sharp bends.
D. Where externally-mounted SPD's are specifically shown on plans, provide circuit breaker as directed by the SPD supplier as a dedicated disconnecting means for SPD unless otherwise indicated.

3.2. FIELD QUALITY CONTROL

A. Ensure that interiors are free of foreign materials and dirt.
B. Check and test switches, pushbuttons, meters for proper operation.
C. Check and test indicating lights for proper operation and color.
D. Perform manufacturer's on site field test procedures.

3.3. STARTUP SERVICE

A. Do not perform insulation resistance (MEGGER) tests of the distribution wiring equipment with the SPDs installed. Disconnect all wires, including neutral, before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4. SYSTEM WARRANTY

A. The SPD system manufacturer shall warranty the entire SPD system against defective materials and workmanship for a period of ten (10) years from the date of substantial completion. This warranty is in effect as long as the unit is installed in compliance with the manufacturer's installation, operation, and maintenance manual, UL Listing requirements, and any applicable national or local electrical codes.
B. Any SPD device which shows evidence of failure or incorrect operation, including damage as the result of lightning strikes, during the warranty period shall be replaced by the manufacturer at no charge to the owner. Warranty will provide for multiple exchanges of any inoperable devices at any time during the warranty period which starts at the date of substantial completion of the system to which the surge suppressor is installed.
C. The manufacturer is required to have a nationwide network of factory-authorized local service representatives for repair and service of this product. The manufacturer shall have a dedicated 1-800 telephone number for service problems and questions. This number shall be manned by a knowledgeable factory employee to ensure prompt response to any emergency situation that may arise.

END OF SECTION 26 43 00

SECTION 26 44 00 - ELECTRICAL HEAT TRACING SYSTEMS

PART 1 - GENERAL

1.1. SCOPE

A. This specification covers the requirements of materials and support services for heat-tracing systems. Heat tracing systems (including insulation and all accessories) shall be provided on all piping installed exposed in exterior locations or where otherwise indicated on plans unless noted otherwise.

1.2. CODES, APPROVALS, AND STANDARDS

A. The electric heat-tracing system shall conform to this specification. It shall be designed, manufactured, and tested in accordance with the applicable requirements of the latest edition of the following codes and standards.
   1. ANSI American National Standards Institute
   2. CEC Canadian Electrical Code
   3. CSA CSA International
   4. FM FM Approvals
   5. IEC International Electro-Mechanical Commission
   6. IEEE Institute Of Electrical and Electronics Engineers
   7. ITS Intertek Testing Services (Intertek ETL SEMKO)
   8. NEC U.S. National Electrical Code (NFPA 70)
   9. NEMA National Electrical Manufacturers Association
   10. NESC National Electrical Safety Code
   11. UL Underwriters' Laboratories, Inc.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

A. Heat Tracing:
   1. Raychem/Tyco Thermal Controls.
   2. Thermon.
   3. Nelson Heat Tracing.
   4. Chromalox.

B. Insulation:
   1. Armstrong World Industries, Inc.
   2. Babcock & Wilcox; Insulationg Products Division
   3. CertainTeed Corporation
   4. Knauf Fiber Glass GmbH
   5. Manville Products Corp.
   6. Owens-Corning Fiber Glass Corp.
   7. Pittsburg Corning Corp.
   8. Rubatex Corp.

2.2. SELF-REGULATING HEATING CABLES

A. All heat-tracing applications with continuous exposure (maintain) temperatures from

150°F (65°C) to 250°F (121°C) or intermittent exposure temperatures from 185°F (85°C) to 420°F (215°C) shall use self-regulating cables.

1. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.
2. Self-regulating heating cable shall be designed for a useful life of 20 years or more with “power on” continuously, based on the following useful life criteria:
   a. Retention of at least 75 percent of nominal rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
   b. Retention of at least 90 percent of nominal rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 746B, IEC 216-1 Part 1.
3. A warranty against manufacturing defects for a period of 10 years shall be available.
4. All cables shall be capable of passing a 2.5 kV dielectric test for one minute (ASTM 2633) after undergoing a 0.5 kg-m impact (BS 6351, Part 1, 8.1.10).

2.3. FREEZE-PROTECTION SYSTEMS

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.

B. The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.

C. In order to provide rapid heat-up, to conserve energy, and to prevent overheating of fluids and plastic pipe, the heating cable shall have the following minimum self-regulating indices:

1. Table K.1 Minimum Self-Regulating Indices

Heating cable	S.R. index (W/°F)	S.R. Index (W/°C)
3 W/ft	0.038	0.068
5 W/ft	0.060	0.108
8 W/ft	0.074	0.133
10 W/ft	0.100	0.180

D. The self-regulating index is the rate of change of power output in watts per degree Fahrenheit or watts per degree Celsius, as measured between the temperatures of 50°F (10°C) and 100°F (38°C) and confirmed by the type test and published data sheets.

1. In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self- ignition, the cable shall produce less than 0.5 watts per foot (1.64 watts per meter) when energized and heated to 350°F (177°C) for 30 minutes. After this test, if the cable is reenergized, it must not have an increasing power output leading to thermal runaway.
2. In order to confirm 3.1B, the self-regulating heating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between

50°F (10°C) and 210°F (99°C), allowing at least six minutes of dwell time at each temperature.

3. The heating cable shall be Raychem® BTV-CT or BTV-CR self-regulating heater, with continuous exposure (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by Tyco Thermal Controls.

2.4. SYSTEMS FOR DIVISION 1 HAZARDOUS LOCATIONS

A. The following requirements shall apply in addition to the criteria specified above:
   1. The self-regulating heating cable shall be specifically FM Approved or CSA Certified for use in Division 1 locations.
   2. A ground-fault protection device set at 30 mA, with a nominal 100 ms response time, shall be used to protect each circuit.
   3. The temperature identification number (T-rating) of the cable used shall comply with FM and CSA requirements as applicable.
   4. Connection methods used with the cable shall be compatible and approved as a part of the system manufactured and supplied by the heating cable vendor for use in the Division 1 location.
   5. For plastic pipe and vessel applications, the heating cable shall be Raychem HBTV-CT or Raychem BTV-CT self-regulating heaters, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by Tyco Thermal Controls.
   6. The heating cable shall be Raychem HQTV-CT or Raychem QTVR-CT self-regulating
      heaters, for continuous and intermittent exposure capability up to 225°F (110°C), as manufactured by Tyco Thermal Controls.

B. Terminations for nonhazardous And hazardous class 1, div 2 locations
   1. All connection components used to terminate heating cables, including power connectors, splices, tees, and connectors shall be approved for the respective area classification and approved as a system with the particular type of heating cable in use. Under no circumstances shall terminations be used which are manufactured by a vendor other than the cable manufacturer.
   2. In order to keep connections dry and corrosion resistant, components shall be constructed of nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated NEMA 4X. The component stand shall allow for up to four inches (100 mm) of thermal insulation.
   3. Terminals shall be spring clamp wire connection type to provide reliable connection, maintenance-free operation, and ease of reentry.
   4. Heating cable terminations shall use cold-applied materials and shall not require the use of a heat gun, torch, or hot work permit for installation.
   5. Components shall be rated to a minimum installation temperature of –40°F (–40°C), minimum usage temperature of –75°F (–60°C), and maximum pipe temperature of 500°F (260°C).
   6. The component system shall be Raychem JBM-100-L-A connection kit complete with integral LED power indicating light to serve as complete power, splice, or tee connection for up to three Raychem BTV, QTVR, or XTV industrial parallel heating cables as manufactured by Tyco Thermal Controls.

2.5. THERMOSTATS AND CONTACTORS

A. Freeze protection systems shall operate using self-regulating control or with the DigiTrace AMC-1A or DigiTrace AMC-F5 thermostat and the DigiTrace E104-100A or DigiTrace E304-40A contactor in nonhazardous locations, and DigiTrace AMC-1H thermostat with Digitrace E307-40A contactor in hazardous locations, as supplied by Tyco Thermal Controls.

2.6. END SEAL

A. An above-insulation, lighted end seal kit shall be provided for each heat trace circuit termination as per the manufacturer's installation details. The kit shall be E-100-LBTV2 as supplied by Tyco Thermal Controls.

2.7. INSULATION

A. All components of the insulation, including covering, mastics and adhesives shall have a flame-spread rating of not over 25, and a smoke development rating of not over 50. Ratings shall be as established by tests in accordance with ASTM E 84 and Federal Specification standards. The integrated insulation assemblies shall also conform to the above specifications. Insulation shall be applied in strict accordance with the manufacturer's instructions.

B. Standard Insulation:
   1. This type of insulation shall be employed for process, cold-and hot water, steam, and condensate piping and equipment with surface temperatures up to 850 degrees F. Pipe insulation and jacketing shall be applied to piping where shown, and shall include fittings, flanges, and valves. Pipe insulation shall be molded-type pipe covering, made of fibrous glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature. Unless otherwise specified the insulation thickness shall be 1" minimum.
   2. The insulation shall be oversized for installation over electric heating cable. Insulation shall have a factory-applied white fire-retardant vapor-barrier jacket of kraft paper and aluminum foil laminated together and reinforced with fiberglass yarn. Fittings and valves shall be covered with the same material as the pipe, cut in segments to fit snugly without open spaces, held in place with copper wire or cement, and then covered with the same jacketing material as the pipe. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-barrier cement before installation of the finish jacket. Pipe insulation and vapor-barrier shall be continuous through hangers and supports. Insulation shall be coordinated with the pipe hangers and supports and where insulation protection shields are provided the top half section of pipe insulation at support locations shall be of the same specified density, and the bottom half insulation segments provided between the pipe and the insulation protection shields shall have a density of not less than 6 lb/cu ft. All insulation shall be covered with smooth aluminum weatherproof metal or plastic preformed jacketing with a factory attached moisture barrier. The jacket for the fittings shall consist of precision-formed smooth-sided sections and shall be sized to cover and protect the insulated fitting. Each section shall be manufactured from aluminum or PVC, and all joints shall be sealed with silicon mastic or solvent welding, to provide a continuous, air and weathertight joint. Strapping shall be 1/2-inch wide, Type 3003 aluminum or stainless steel.

C. Removable Blanket Insulation:

1. This type of insulation shall be employed for process, cold-and hot water, steam, and condensate piping and equipment with surface temperatures up to 850 degrees F. Removeable blanket insulation and jacketing shall be applied to all heat traced valves, bends in pipes, and other equipment/devices where maintenance or inspection may be required. Removeable blanket design shall be sewn construction only. Hog-ring construction with mechanical fasteners will not be permitted. Minimum k-factor, thickness, etc. shall match that of the associated standard insulation. Insulation shall be completely weatherproof.

PART 3 - EXECUTION

3.1. GENERAL

A. Heat tracing shall be provided along full length of all exposed piping or vessels located outside of buildings or in other areas designated on plans (such as by insulated piping in areas subject to cold temperature). Insulation shall be provided over all heat traced pipes.

B. The vendor shall provide a detailed design utilizing standard heat-tracing design software, such as Tyco Thermal Controls TraceCalc® Pro design software or equal. At minimum, the design must provide the following:
   1. Circuit identification number
   2. Maintain temperature
   3. Line size and insulation
   4. Heat loss for pipe, valves, and supports
   5. Amount and type of heating cable required
   6. Spiral requirements
   7. Heating cable service voltage
   8. Heating cable power output at the maintain temperature
   9. Minimum and maximum maintain temperature vs. minimum and maximum ambient temperatures
   10. Circuit breaker and transformer sizing

C. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

D. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:
   1. Bolted flanges (per pair): Two times pipe diameter
   2. Valves: Four times valve length
   3. Pipe hanger or support penetrating insulation: Three times pipe diameter

E. The entire system shall be installed in compliance with the manufacturer’s recommendations for a fully-functional, code-compliant system.

F. All insulation shall be installed by a qualified insulation contractor in strict accordance with the manufacturer's recommendations and the requirements of these specifications.

G. All piping insulation shall be installed following required testing and approval of piping.

3.2. IDENTIFICATION

A. Heat tracing systems shall be labeled at the field connection of power to the heat tracing equipment per the requirements for Utilization Equipment within Specification Section 26 05 53.

B. Heat traced piping, vessels, etc. shall be identified with appropriate caution signs or markings at intervals not exceeding 20 feet on center per NEC requirements.

3.3. TESTING

A. Factory inspections and tests for self-regulating, power limiting, series constant wattage and constant wattage (MI) heater cables shall include but are not limited to the following:
   1. Testing shall be done per the latest IEEE Std. 515 test section and applicable manufacturer's standards.
   2. In the field, all heater cables shall be meggered. The following separate field megger readings shall be taken on each self-regulating and each M.I. heater cable:
      a. Heater cable shall be meggered when received at jobsite before installation.
      b. Heater cable shall be meggered after installation, but before insulation is applied.
      c. Heater cable shall be meggered after insulation has been installed.
   3. All three of the above field megger readings shall be greater than 20 megohms. Otherwise, the heater cable is not acceptable and shall be replaced.
   4. Field megger tests shall be recorded for each heater cable, and certified reports shall be submitted to the user.

END OF SECTION 26 44 00

SECTION 26 50 00 - LIGHTING MATERIALS AND METHODS

PART 1 - GENERAL

1.1. DESCRIPTION

A. Lighting Fixtures
B. Drivers

1.2. SUBMITTALS

A. Complete submittals shall be provided identifying all lighting fixture types and options, all lamp types (where applicable) and compliance with all contract requirements. The absence of clear submittal information specifically listing exceptions/deviations from detailed contract requirements will be understood to indicated that the contractor/supplier intends to meet all contract requirements. Refer to specification section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1. GENERAL

A. Lighting fixtures shall be furnished as shown on plans and specified herein. It shall specifically be the responsibility of Contractor to verify exact types ceilings, walls, etc. and recessing depth of all recessed fixtures and furnish the specific mounting trims and accessories of the specified and/or accepted fixture specifically for the ceiling, wall etc. in which each fixture is to be installed.
B. Base bid manufacturers are listed on the lighting fixture schedule. Manufacturers listed without accompanying catalog numbers are responsible for meeting the quality standards, efficiency, maximum wattages and photometric distributions set by the specified product.
C. All lighting fixtures shall be so designed and shall have drivers and other similar items so installed as to function without interruptions or failures when operating in the environment in which they are proposed to be installed. Special attention shall be given to environments with potentially high ambient temperatures such as attic spaces, exterior soffits, confined interior soffits, coves, unconditioned spaces, etc. and shall be addressed by providing fixtures with suitable high ambient temperature ratings, remote mounting of drivers/ballasts, providing approved ventilation, etc. as directed by fixture manufacturer and approved by engineer, at contractor’s expense.
D. All fixtures installed such as to create penetrations through fire rated ceiling or wall assemblies shall be labeled as suitable for that purpose or installed with covers, tenting or other means as required to maintain the fire rating of the assembly.

2.2. LED LUMINAIRES

A. For the purpose of these specifications, LED Luminaires shall be defined as the entire LED fixture assembly including LED array, drivers, housing, electronics, etc. that compose the lighting fixture.
B. Furnish and install LED Luminaire of proper size, type, efficacy, delivered lumen output, color temperature, distribution pattern, operational life, and CRI as shown on drawings.
C. LED Luminaires shall be tested in accordance with LM-79 and LM-80 standards.

D. LED drivers shall comply with NEMA 410 standards for inrush current, etc.
E. Exterior, pole mounted LED Luminaires shall be provided with an easily-serviceable, UL recognized surge protection device that meets a minimum 10kA Category C Low operation (IECC C62.41.2-2002). Device shall be wired in front of light engine(s) and driver(s) and shall fail "open" such as to prevent fixture operation after a surge protection failure.
F. LED Luminaires shall have a guarantee-warranty of at least five years unless specifically noted otherwise on contract documents.
G. LED Luminaire assembly shall comply with ambient temperature requirements specified in General section above.

2.3. STEMS/PENDANTS

A. Hangers shall be approved ball aligner type swivel, 30 degrees from vertical with swivel below canopy.
B. Stems/Pendants shall be rigid conduit unless specified otherwise on plans. Proposed stem/pendant types shall be submitted for review prior to shipment of light fixtures from factory.
C. Stems/Pendants shall be provided as required to prevent swaying of fixtures due to HVAC system airflow or other similar occurrences.
D. Shall be painted the same color as the fixture trim unless noted otherwise.

2.4. MANUFACTURER

A. Fixtures and stems shall be manufactured as shown in fixture schedule or approved equals.
B. Drivers shall be as manufactured by Philips/Advance, GE, Lutron, Magnatec, Motorola, EldoLED or approved equal.

PART 3 - EXECUTION

3.1. INSTALLATION OF LIGHTING FIXTURES

A. Support:
    1. Support of all lighting fixtures shall be responsibility of electrical contractor. All lighting fixture supports shall be installed in accordance with lighting fixture supplier's recommendations.
    2. Contractor shall coordinate installation requirements for all wall-mounted fixtures (especially for wall-mounted fixtures on uneven wall surfaces, etc.) as required to assure a level/flat mounting surface and level/plumb/secure finished installation. Contractor shall provide flat mounting plates or other mounting provisions where necessary. Any proposed mounting plates, etc. shall be submitted to and approved by project architect prior to ordering materials.

B. Row-Mounted fixtures:
    1. All stems on row-mounted fluorescent fixtures shall be installed as follows (except fixtures with slide grip hangers):
        a. One stem shall be installed in the first fixture knockout from end of row (on the first and last fixture of the row).
        b. One stem shall be installed between each two fixtures. Stem shall center joint where fixtures join and shall attach by use of "joining plates".

2. All fixtures in continuous rows other than recessed grid type shall be connected by nipples with locknuts bushings.

C. Coordination:
   1. Contractor shall coordinate all dimensions & locations of light fixtures prior to rough-in to insure proper fit and coordination with other trades.
   2. Contractor shall verify exact ceiling types being installed and shall adjust fixture trim types accordingly (prior to submitting light fixture shop drawings).

END OF SECTION 26 50 00

SECTION 27 05 00 - AUXILIARY SYSTEM CABLES, 0-50V

PART 1 - GENERAL

1.1. DESCRIPTION

A. Cables rated for 0V-50V application

PART 2 - PRODUCTS

2.1. GENERAL

A. Unless specified otherwise, all cables within the scope of this specification section shall:
   1. Be rated for exposed cable tray installation.
   2. Be plenum rated (Class 1 Control cabling and Instrumentation cabling installed in conduit or exposed in cable tray in non-plenum areas is not required to be plenum-rated).
   3. Be UL-rated for the proposed application.
   4. Be multi-conductor with overall outer sheath as required by the application. The insulation of each conductor within the overall multi-conductor cable shall be uniquely color-coded. Ground conductors (when provided) within the multi-conductor cable shall have green insulation. Conductors with green insulation shall not be used for conductors other than ground.
   5. Utilize copper conductors.
   6. Have wire gauge as required to limit voltage drop to acceptable limits determined by the system supplier and to meet all applicable code requirements.
   7. Where installed underground, within slab-on-grade or in exterior locations, be rated for wet locations.
   8. Where required for specific systems, meet the specific requirements (conductor quantity, wire gauge, insulation type, shielding, etc.) of the system supplier.

2.2. INSTRUMENTATION CABLING

A. In addition to above requirements, and unless specified otherwise, Instrumentation cabling shall:
   1. Be #16awg minimum.
   2. Be rated for 300V.
   3. Have aluminum foil shielding.
   4. Have stranded, twisted conductors.
   5. Have PVC insulation/jacket with ripcord.
   6. Be manufactured by Belden, AlphaWire or General Cable.

2.3. CLASS 1 CONTROL CABLING (120VAC CONTROL CIRCUITS, ETC.)

A. In addition to above requirements, and unless specified otherwise, Class 1 control cabling shall:
   1. Be rated for 600V.
   2. Be industrial grade.
   3. Have stranded conductors.
   4. Have sunlight/oil-resistant PVC/Nylon insulation and jacket with ripcord.
   5. Be manufactured by Belden, AlphaWire or General Cable.

2.4. CLASS 2 & 3 CONTROL CABLING (FED FROM CLASS 2 OR 3 POWER SUPPLIES)

A. In addition to above requirements, and unless specified otherwise, Class 2 & 3 control cabling shall:
   1. Be rated for 300V.
   2. Be shielded if so recommended by the system supplier/integrator.
   3. Have twisted conductors.
   4. Have plenum-rated insulation/jacket with ripcord.
   5. Be manufactured by AlphaWire, Belden, General Cable, Superior Essex or West Penn.

2.5. NETWORK CABLING

A. Furnish and install all Ethernet, Fiber Optic and Backbone Copper Telephone cabling in accordance with all BICSI requirements and in accordance with other applicable specification sections.

PART 3 - EXECUTION

3.1. GENERAL INSTALLATION

A. Routing:
   1. All wires and cables shall be installed in conduit unless specifically noted otherwise. Where conduit is not otherwise required by contract documents, 0-50V Cabling located within concealed, accessible ceiling spaces (such as above lay-in ceilings) may be run without conduit if the following requirements are met:
      a. Cabling is plenum-rated, multi-conductor.
      b. Cabling is supported by cable tray or with J-hook supports on intervals not to exceed 5’-0” on center. Cabling shall be supported solely from the cable tray or j-hooks supported from the building structure, without using piping, ductwork, conduit or other items as supports.
      c. Cabling is neatly formed, bundled and tied with plenum-rated Velcro straps on intervals not to exceed 30” on center.
      d. Properly-sized conduit(s) are provided wherever cabling enters an inaccessible or exposed area (such as above gyp board ceilings, within walls or through walls).
      e. Cabling is not a part of a Fire Alarm System, Smoke Control System, Emergency Generator Control System or other life-safety related system.
   2. End bushings shall be provided on both ends of all raceway terminations.
   3. No splices shall be pulled into conduit.
   4. No cabling shall be pulled until conduit is cleaned of all foreign matter.

B. Penetrations:
   1. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly.
   2. For cabling not installed in conduit:
      a. Fire/smoke barrier penetrations shall be sealed utilizing an enclosed fire-rated pathway device (STI EZ Path or equal) containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to remove or reinstall firestop

materials. The pathway shall be UL Classified and tested to the requirements of applicable ASTM/UL1479 standards.

3. For cabling installed within conduit from endpoint to endpoint:
   a. Fire/smoke barrier penetrations shall sealed utilizing fire caulk or other equivalent firestop systems around perimeters of conduits per UL requirements.
4. For cabling installed within cable trays:
   a. Fire/smoke barrier penetrations shall be sealed with one of the following methods:
      1) Continuous cable tray through the penetration, with a combination of large firestop pillows and small firestop pillows contained, supported and secured (to prevent unauthorized removal) on both sides by aluminum wire mesh and firestop putty. Firestop pillows shall be STI Series SSB or equal and Firestop putty shall be STI Spec Seal or equal.
      2) Cable tray broken at the penetration, with fire/smoke barrier penetrations sealed utilizing an enclosed fire-rated pathway device (STI EZ Path or equal) containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and tested to the requirements of applicable ASTM/UL1479 standards.

C. Excess Cabling:
   1. Excess cabling shall be neatly coiled within all junction boxes, pullboxes, wireways, etc. and at all terminations as required to allow future re-termination of cabling.

D. Terminations:
   1. All conductors/cabling (including spare conductors) shall be properly terminated unless specifically directed otherwise. See below for general termination hardware requirements.
   2. Cabling shall be neatly formed, bundled and tied at all terminations.

3.2. SPLICES/CONNECTIONS/TERMINATIONS:

A. Network Cabling:
   1. Network and fiber optic cabling shall be continuous from endpoint to endpoint and shall not be spliced unless specifically noted otherwise.

B. Control Cabling:
   1. Connections shall be made with T & B Sta-Kon wire joints EPT66M, complete with insulating caps. To be installed with WT161 Tool or C nest of WT11M Tool, Ideal Super - Nuts (not wire nuts), Ideal Wing Nuts, or Buchanan Elec. Products B Cap or Series 2000 Pressure connectors complete with nylon snap on insulators to be installed with C24 pressure tool.

C. Shielded cabling:

1. Unless directed otherwise by the system supplier, 0-50V cable shielding shall be grounded at the PLC/control panel end only (not at the field device end) with a termination kit as directed by the PLC/control panel supplier.
2. Shielded cabling shall be continuous from endpoint to endpoint and shall not be spliced without prior written approval from the Engineer.

3.3. LABELING

A. Refer to Specification Section 26 05 53 for all labeling requirements.

END OF SECTION 27 05 00

SECTION 27 10 00 - STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1. SCOPE:

A. This document describes the products and execution requirements relating to furnishing and installing Telecommunications Cabling. Backbone and Horizontal cabling comprised of copper and fiber cabling, and support systems are covered under this document.
B. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the structured cabling contractor as detailed in this document.
C. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types are indicated on the plans. If the bid documents are in conflict, this specification shall take precedence.
D. Refer to Specification Section 26 05 53 (Electrical Identification) for additional identification requirements.
E. Refer to Specification Section 27 05 00 (Auxiliary System Cables, 0-50V) for additional material and installation requirements.

1.2. REGULATORY REFERENCES:

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the National Electrical Code, local ordinances and present manufacturing standards.
B. All materials shall be UL Listed and shall be marked as such. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.
C. All modular jacks, patch cords, consolidation point, and patch cords shall be ETL Verified (not just tested) to be category 6 component and channel compliant.
D. The cabling system described in this specification is derived from the recommendations made in recognized telecommunications industry standards. The following documents are incorporated by reference:
    1. ANSI/TIA/EIA - 568-B.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements, April, 2001
    2. ANSI/TIA/EIA - 568-B.2, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components, April, 2001
    3. ANSI/TIA/EIA - 568-B.2-1, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted Pair Cabling Components, Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ω Category 6 Cabling
    4. ANSI/TIA/EIA - 568-B.3, Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Components, March, 2000
    5. ANSI/TIA/EIA – 569-A, Commercial Building Standard for Telecommunications Pathways and Spaces, February, 1998
    6. ANSI/TIA/EIA – 606-A, Administration Standard for Telecommunications Infrastructure of Commercial Buildings, February, 2002

7. ANSI/TIA/EIA – 607-AJ, Commercial Building Grounding and Bonding Requirements for Telecommunications, August 1994
8. ANSI/ TIA/EIA – 758, Customer-Owned Outside Plant Telecommunications Cabling Standard, April 1999
9. BICSI - TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM) 10TH edition.
10. National Fire Protection Agency (NFPA – 70), National Electrical Code (NEC) – 2002
11. ANSI/TIA/EIA – 45-B, Test Procedures for Fiber Optic Connections.
12. ANSI/TIA/EIA – 526-14, Power Test for Fiber Runs.
13. FCC 47 CFR 68
14. NEMA 250
15. NEC Articles 770 and 800
16. ADA, Americans with Disabilities Act

E. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release.

F. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project. All local State and federal codes are to be followed.

1.3. APPROVED CONTRACTOR:

A. The Structured Cabling Contractor must meet the following requirements:
1. Contractor must have a certified RCDD on staff. The project manager for this project shall have an RCDD certification, and RCDD shall be responsible for reviewing all aspects of the design, submittals and installation of all products.
2. All required submittal information shall be stamped by the RCDD.
3. Contractor must have a minimum of 3 years experience with projects of similar size and scope to this project.
4. The company performing the work must have been in business for a minimum of 3 years.
5. The company must have an office within 75 miles of the job site.

B. The Structured cabling contractor is responsible for workmanship and installation practices in accordance with the requirements of the standards described in these specifications and manufacturer's requirements.

1.4. WORK INCLUDED:

A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The structured cabling contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

B. The work shall include, but not be limited to the following:
1. Furnish and install a complete telecommunications wiring infrastructure.
2. Furnish, install, and terminate all UTP and Optical Fiber cable

3. Furnish and install all wall plates, jacks, patch panels, and patch cords at equipment racks and at work outlets (unless shown otherwise on plans).
4. Furnish and install all required cabinets and/or racks as required and as indicated.
5. Furnish any other material required to form a complete system.
6. Perform channel testing (100% of horizontal and/or backbone links/channels) and certification of all components.
7. Furnish test results of all cabling to the owner on disk and paper format, listed by each closet, then by workstation ID.
8. Provide owner test results and documentation. (Testing documentation and As-built drawings)

1.5. SUBMITTALS:

A. Within thirty (30) days of notice to proceed the structured cabling contractor shall submit the following items:
   1. Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this spec.
   2. Submit proof from manufacturer of contractor's good standing in manufacturer's certification program.
   3. Submit copy of contractor's RCDD certification.
   4. Submit listing of five (5) projects of similar size and scope to this project that have been completed within the last five years. Include in this submittal owner's contact information for each project.
   5. Submit letter from the manufacturer stating that the manufacturer will provide a twenty-five year (25) warranty in accordance with the requirements paragraph 1.03 (B) of these specifications.
   6. Submit appropriate cut sheets and samples for all products, hardware and cabling.
   7. Submit 1/8" = 1'-0" drawings of floor plans indicating all work outlets and the labeling designation for each jack.
   8. Submit ½" = 1'-0" drawings of each MDF and each IDF showing all racks, patch panels, 110 blocks, etc.

B. Work shall not proceed without the engineer's approval of the submitted items.
C. The structured cabling contractor shall receive approval from the engineer on all substitutions of material. No substituted materials shall be installed except by written approval from the engineer.

1.6. DRAWINGS:

A. It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the structured cabling contractor in bidding the job. The structured cabling contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.
B. The structured cabling contractor shall verify all dimensions at the site and be responsible for their accuracy.

PART 2 - PRODUCTS

2.1. EQUIVALENT PRODUCTS:

A. Due to the nature and type of communications all products, including but not limited to faceplates, jacks, patch panels, racks, 110 blocks, and patch cords, for the purpose of this document, shall be manufactured by Hubbell, Ortronix, Panduit, Amp or Systimax. See below for acceptable cable manufacturers.

2.2. HORIZONTAL DISTRIBUTION CABLE:

A. Horizontal Distribution Cabling shall meet the following requirements:
   1. Shall be 100 Ohm Enhanced Category 6 Unshielded Twisted Pair (UTP) Cable.
   2. Physical Characteristics:
      a. Unless directed otherwise by owner (contractor shall verify with owner), Cat6 cable coloring shall be based on system type as follows, unless specifically approved otherwise:
         1) Data (or IP Voice): Blue
         2) Analog Voice: Grey
         3) Lighting Control System: White
         4) Fire Alarm or other Life-Safety System: Red
         5) CCTV Surveillance Cameras: Yellow
         6) Other: As directed by owner
      b. Shall be plenum-rated.
      c. Shall meet applicable requirements of ANSI/ICEA S-80-576.
      d. The diameter of the insulated conductor shall be .023 in. maximum.
      e. Shall consist of (4) 22-26 AWG twisted pairs.
      f. The overall diameter of the cable shall be no larger than 0.240 inches.
      g. The ultimate breaking strength measured in accordance with ASTM D 4565 shall be 400 N minimum.
      h. Cable shall withstand a bend radius of 1 inch at -20 degrees Celsius without jacket or insulation cracking.
      i. Cable shall be third party verified to meet ANSI/TIA/EIA-568-B.2-1.
      j. Where installed underground, within slab-on-grade or in exterior locations, be gel-filled and rated for wet locations.
   3. Transmission Characteristics:
      a. DC resistance of any conductor shall not exceed 9.38 Ohms per 100m max. at 20º C. Measured in accordance with ASTM D 4566.
      b. The mutual capacitance of any pair at 1 kHz for 100m of cable shall not exceed 4.4 nF nominal.
      c. DC resistance unbalance any two conductors of any pair shall not exceed 5% when measured at or corrected to 20° C in accordance with ASTM D 4566.
      d. Structural return loss swept measurement for 100m or longer shall meet or exceed Category 6 requirements.
   4. Shall be manufactured by Amp NetConnect, Berk-Tek, General Cable, Mohawk or Superior Essex.

2.3. BACKBONE - FIBER:

A. Backbone Fiber Optic Cabling shall meet the following requirements:
   1. All optical fiber shall be Indoor/Outdoor,Tight-Buffered, All-Dielectric, Plenum rated (unless specified otherwise on plans) with Enhanced Multimode OM4-rated 50/125 Optical Fibers.

2. Each Multimode Fiber shall:
    a. Be graded-index optical fiber wave-guide with nominal 50/125μm-core/cladding diameter.
    b. Comply with ANSI/EIA/TIA-492AAAC-A
    c. Have attenuation measured in accordance with ANSI/EIA/TIA-455-46, 53 or 61.
    d. Have information transmission capacity measured in accordance with ANSI/EIA/TIA-455-51 or 30.
    e. Have measurements performed at 23 degrees C +/- 5 degrees.
    f. Have Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.0
    g. Have bandwidth $\geq$ 4700 MHz-km @ 850nm. (EMB)
    h. Have bandwidth $\geq$ 500 MHz-km @ 1300nm.
    i. Be laser optimized and guarantee a 1 Gb/s distance of 1000 meters @ 850nm and 10 Gb/s at 600 meters @ 850nm.
    j. Terminate on fiber patch panel using SC Type fiber connectors.
3. Each indoor/outdoor fiber optic cable shall:
    a. Be suitable for use in both outdoor and indoor applications without the use of a transition at the building entrance.
    b. Be suitable for use in risers, plenums and horizontal applications.
    c. Have a dry water blocking system for cable.
    d. Have a fiber strand count of 12 (unless shown otherwise on plans).
    e. Have a nominal 2.21 mm sub-unit diameter.
    f. Have and be marked with an UL-OFNP Flame Rating (unless engineer specified otherwise on plans).
    g. Comply with Bellcore GR-409 and GR20
    h. Be independently verified to comply with ICEA S-104-696
    i. Have strength members of FGE/Aramid yarn.
    j. Be suitable for underground or above ground conduits.
    k. (Where applicable) Have Tight Buffered fibers color coded in accordance with EIA / TIA 598 with an overall black jacket.
    l. Be suitable for operation between -40° to +70° C
    m. Be UV resistant
    n. Be of an all dielectric design
4. Shall be manufactured by Berk-Tek, Corning, General Cable or Superior Essex.

2.4. PATCH CORDS:

A. The structured cabling contractor shall provide factory terminated and tested UTP and optical fiber patch cords and equipment cords for the complete cabling system. Patch cords shall be provided by the structured cabling contractor to connect patch panels to owner furnished electronics. The UTP patch cables shall meet the requirements of ANSI/TIA/EIA-568-B.2 and ANSI/TIA/EIA-568-B.2-1 for patch cord testing. Provide one set of optical fiber patch cables per fiber run that terminates on fiber patch panel and provide one category 6 patch cord for each category 6 work outlet that terminates on patch panel.

B. Copper (UTP) patch cords shall:
    1. Be furnished to connect each patch panel jack to owner supplied electronics.
    2. Be furnished for each work outlet jack.
    3. Be a Category 6 patch cord manufactured by Panduit, Amp or Systimax.
    4. Use 8 position connector with impedance matched contacts and designed using dual reactance.

5. Be constructed of 100 ohm, 4 pair, 24 AWG, stranded conductor, unshielded twisted pair copper per the requirements of the ANSI/TIA/EIA-568-B.2 and ANSI/TIA/EIA-568-B.2–1 standard.
6. Meet TIA category 6 component specifications in ANSI/TIA/EIA-568-B.2-1 100% factory tested to meet category 6 performance and ETL or any other nationally recognized 3rd party verification
7. Be capable of universal T568A or T568B wiring schemes.
8. Have modular connector that shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.
9. Have a performance marking indelibly labeled on the jacket (by the manufacturer).
10. Have the ability to accept color-coded labels and icons to comply with ANSI/TIA/EIA-606-A labeling specifications.
11. Have “snagless” protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief
12. Be available in three standard colors
13. Be available in 3 foot, 5 foot, 7 foot, 10 foot, and 14 foot standard lengths
14. Be backwards compatible to Category 3, 5 and 5e

C. Fiber Optic patch cords shall:
1. Be furnished in the quantity of two (2) per IDF in each IDF and two (2) per IDF in each MDF.
2. Be manufactured by Panduit, Amp or Systimax.
3. Be multimode OM4 type.
4. Have connector type as directed by owner.
5. Have a performance marking indelibly labeled on the jacket (by the manufacturer).
6. Have the ability to accept color-coded labels and icons to comply with ANSI/TIA/EIA-606-A labeling specifications.
7. Be available in three standard colors
8. Be available in 3 foot, 5 foot, 7 foot, 10 foot, and 14 foot standard lengths

PART 3 - EXECUTION

3.1. PRE-INSTALLATION SITE SURVEY:

A. Prior to start of work, meet at the project site with the owner’s representative and representatives of trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with the work. Facilitation with the General Contractor will be necessary to plan the crucial schedule completions of the equipment rooms and telecommunication closets.
B. Examine areas and conditions under which the system is to be installed. Do not proceed with work until satisfactory conditions have been achieved.

3.2. HORIZONTAL DISTRIBUTION CABLE INSTALLATION:

A. All horizontal voice and data cabling shall be terminated on modular patch panels except for horizontal voice cables serving life safety related functions (fire alarm systems, security systems, elevator communications, etc.). All horizontal voice cabling serving life safety related functions shall be terminated on 110 blocks.
B. The voice and data cables shall be installed in separate patch panels.
C. All wiring above ceilings shall be installed in cable tray or open top cable hangers or in

provided conduit.

D. Cable above accessible ceilings shall be supported 60” on center from cable support attached to building structure.
E. Do not untwist cable pairs more than 0.5 in. when terminating.
F. The Contractor shall be responsible for replacing all cables that do not pass Category 6 requirements for data and 5e for the voice applications.
G. Maximum horizontal cable length shall be 90 meters.
H. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
I. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in closets. Leave sufficient cable for 90° sweeps at all vertical drops.
J. Do not install Category 6 cable with more than 110N (25 lbs) pull force, as specified in ANSI/TIA/EIA and BICSI TDDM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 100 lineal feet with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends. Use of tensile rated cords (i.e. fishing line) should be used for difficult or questionable pulls - to judge to go/no-go condition of the conduit and pulling setup.
K. Cables jackets that are chaffed or burned exposing internal conductor insulation or have any bare copper (“shiners”) shall be replaced.
L. Test, label and document as called for in contract documents.
M. Firestop all openings where cable is installed through a fire barrier.

3.3. OPTICAL FIBER TERMINATION HARDWARE:

A. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.
B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
C. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
D. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
E. A maximum of 12 strands of fiber shall be spliced in each tray
F. All spare strands shall be installed into spare splice trays.

3.4. BACKBONE CABLE INSTALLATION:

A. Raceways:
    1. All backbone cables shall be installed inside innerducts (see specification above) within conduits meeting specification requirements unless specifically noted otherwise.
    2. Backbone cables shall be installed separately (in separate innerducts/conduits) from horizontal distribution cables.
    3. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
    4. Where backbone cables and distribution cables are specifically specified to be installed in a cable tray or wireway, backbone cables shall be installed first, within innerducts meeting specifications above, bundled separately from the horizontal distribution cables.

B. Support:
    1. Within Telecommunications Rooms or at Telecommunications Backboards, all backbone cables shall be securely fastened to the backboards on the walls.
    2. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
    3. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
    4. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

3.5. COPPER TERMINATION HARDWARE:

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-A/B standard, manufacturer's recommendations and best industry practice.
B. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
E. The cable jacket shall be maintained to within 25 mm (one inch) of the termination point.
F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.6. IDENTIFICATION AND LABELING:

A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful structured cabling contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. Labeling shall follow the guidelines of ANSI/TIA/EIA-606-A.
B. All label printing will be machine generated by Panduit software (or other) using indelible ink ribbons or cartridges. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

3.7. TESTING AND ACCEPTANCE:

A. General
    1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling

system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

2. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, the Panduit Certification Program Information Manual and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

B. Copper Channel Testing

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using a Level III test unit for category 6 performance compliance, respectively.
2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
3. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B.1 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
4. Category 6 Performance:
    a. Follow the Standards requirements established in:
        1) ANSI/TIA/EIA-568-B .1, B.2 and B.2-1
    b. A Level III test unit is required to verify category 6 performance.The basic tests required are:
        1) Wire Map
        2) Length
        3) Attenuation
        4) NEXT (Near end crosstalk)
        5) Return Loss
        6) ELFEXT Loss
        7) Propagation Delay
        8) Delay skew
        9) PSNEXT (Power sum near-end crosstalk loss)
        10) PSELFEXT (Power sum equal level far-end crosstalk loss)

C. Fiber Testing

1. All fiber testing shall be performed on all fibers in the completed end to end system. There shall be no splices unless clearly defined in an RFP. Testing shall consist of an end to end power meter test performed per EIA/TIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers and 1310 and/or 1550 nanometers for single mode fibers. These tests also include continuity checking of each fiber.

2. Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for singlemode) in both directions.
3. Test set-up and performance shall be conducted in accordance with ANSI/EIA/TIA-526-14 Standard, Method B.
4. Where links are combined to complete a circuit between devices, the structured cabling contractor shall test each link from end to end to ensure the performance of the system. ONLY LINK TEST IS REQUIRED. The structured cabling contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.
5. Attenuation testing shall be performed with an approved hand held tester from an industry recognized test equipment manufacturer.

3.8. SYSTEM DOCUMENTATION:

A. Upon completion of the installation, the structured cabling contractor shall provide three (3) full documentation sets to the owners for approval. Documentation shall include the items detailed in the sub-sections below.
B. Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test result and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the Engineer, the structured cabling contractor shall provide copies of the original test results.
C. The Engineer may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the structured cabling contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.9. TEST RESULTS:

A. Test documentation shall be provided on disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation”, the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
B. The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-A/B including applicable TSB’s and amendments. The appropriate Level III tester shall be used to verify Category 6 cabling systems.
C. Test results generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. The structured cabling contractor must furnish this information in electronic form (CD-ROM).

D. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

3.10. WARRANTY:

A. The manufacturer shall provide a 25 year extended product warranty with a 25 year applications assurance warranty. Manufacturer shall provide the warranty directly to the end user.
B. An Extended Product Warranty shall be provided which warrants functionality of all components used in the system for 25 years from the date of registration. The Extended Product Warranty shall warrant the installed horizontal copper and the backbone optical fiber portions of the cabling system.
C. The Application Assurance Warranty shall cover the failure of the wiring system to support current or future applications that are designed for the link/channel specifications of ANSI/TIA/EIA–568-B.1. These applications include, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, and 155 Mb/s ATM.
D. The contractor shall provide a warranty on the physical installation.

3.11. FINAL ACCEPTANCE & SYSTEM CERTIFICATION:

A. Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two week period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a numbered certificate, from the manufacturer, registering the installation.

END OF SECTION 27 10 00

SECTION 27 60 00 - SCADA SYSTEM

PART 1 - GENERAL

1.1. DESCRIPTION

A. Work included: Provide a complete SCADA System with instrumentation and controls with appurtenant equipment and accessories as indicated, specified, and as necessary for a complete and proper operating system.
   1. Work includes, but not necessarily limited to, the following:
      a. All programmable logic controllers (PLCs), instruments, and other appurtenances as indicated and specified herein and as required by the process flow and instrumentation diagrams and descriptions.
      b. All engineering, hardware and software development, installation, startup, calibration services and supervision necessary.
      c. Testing and operational demonstrations as specified.
      d. Training programs as specified.
      e. Preparation of manuals.
      f. Programming of screens, alarms, historian, trending, etc. for the SCADA Computer system.

B. Related work:
   1. Documents affecting work of this Section include, but are not necessarily limited to, General Specifications, Special Provisions, and all other related Sections.
   2. Refer to Specification Section 26 29 00 for additional control panel requirements.
   3. If applicable, refer to Specification Section 27 60 01 for SCADA Functional Descriptions (to be provided within construction phase of project unless indicated otherwise).
   4. Refer to Specification Section 27 60 05 for instrumentation requirements.
   5. Refer to plans for point lists and additional device requirements.

1.2. QUALITY ASSURANCE

A. The qualifications and experience of key project personnel shall be acceptable to the Engineer. The System Integrator shall employ competent service personnel to service and troubleshoot the control and instrumentation systems and shall have at least 15 years of experience with similar work. References shall be provided upon request by the Engineer. The System Integrator shall maintain their own UL508 panel shop. The geographic location of a fully staffed office with Engineers, Service Personnel, and programmers shall be within a 150 mile radius of the project site. The System Integrator approved for this project is:
   1. M/R Systems – Atlanta, Georgia

B. The system integration duties shall be provided by a company qualified, experienced, and regularly engaged in designing, setting up, programming, and integrating complex process loop controls and instrumentation for process control and monitoring applications. Only qualified system integrators will be allowed to submit proposals for this project. In order to be considered qualified, integrator shall have completed a minimum of five (5) projects of similar type/scope and equal or greater magnitude and complexity within the last ten (10) years. Sub-contractors without qualifications will be rejected. Previous projects used to meet this experience requirement must have

included similar (or greater) scopes of work for each of the following areas:
1. Process loop controls for the proposed processes
2. HMI graphics
3. Instrumentation
4. Control Panel/PLC panel construction

C. The System Integrator shall have and shall maintain a qualified technical and support staff. The System Integrator shall employ a Control Systems Engineer or Electrical Engineer to supervise or perform the work required by this Specification. The SI shall employ service personnel on this project who have successfully completed ISA certification Level 1 or higher and manufacturer's training courses on general process instrumentation and configuration and implementation of the specific process controllers and software proposed for this project.
D. The System Integrator or it's personnel engaged in this project shall have and shall maintain, at a minimum, the first three (3) certificates of ISA 62443 (for cybersecurity of industrial automation and control systems).
E. Contractor:
1. Shall be fully and solely responsible for the work of the systems supplier and solely responsible to the Owner for having supplied to the Owner the complete integrated SCADA system.
2. To provide personal superintendence and direction of the work, maintaining and supplying complete supervision over and coordination between all subcontractors employed by him and the Instrumentation and Control System Integrator.
3. To be responsible for defining the limits of his subcontractor's work.
4. To be responsible for setting of instruments (including alarms, etc. as provided under other sections).

F. Operation and Maintenance Manuals
1. Operating instructions shall incorporate a functional description of the entire system, including the system schematics which reflect "as-built" modifications.
2. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.
3. As part of the operation and maintenance manuals, provide one hard copy of the program used to program the programmable logic controller.

1.3. WARRANTY

A. Systems supplier shall furnish a hardware and software warranty for the system starting at substantial completion and ending one year from this date.

1.4. REFERENCES

A. Instrument Society of America (ISA) PR7. 1, Pneumatic Control Circuit Pressure Test, Tentative Recommendation Practice.
B. Instrument Society of America (ISA) S5.4, Instrument Loop Diagrams, standard.
C. National Electrical Manufacturers Association (NEMA) Publication, General Standards for Industrial and Control Systems, ICS 1 and Industrial Controls and Systems ICS2.

1.5. SUBMITTALS

A. General/System submittal requirements:
1. Provide submittal (quantity as required by contract) of:

a. Component manufacturing data sheets indicating pertinent data and identifying each component (including all components within PLC/control panel enclosures, instruments, computer systems, surge protection devices, antennae, radios, sun/rain shields, etc.) by tag number and nomenclature as indicated on drawings and in specifications.
b. Component drawing showing dimensions, mounting, and external connection details,
c. SCADA Network Diagram showing all major network equipment (including all PLCs, RTUs, Ethernet Switches, Computer System components, network cabling networked I/O, etc.).
d. List of all spare parts. All manufacturers recommended spare parts shall be provided in addition to required spare parts.
e. Shop test plan and results.
f. Propagation study results.

2. Identify any specification section where exceptions are being taken or an "or equal" piece of hardware is being proposed.
3. A Bill of Materials shall be included with catalog information on all components.
4. Information shall be included on any proprietary logic component sufficient to demonstrate its ability to perform the required functions.

B. Panel submittal requirements:
1. A job-specific, custom wiring diagram
a. The wiring diagram shall clearly show all components (whether the components are mounted internal or external to the control panel enclosure).
b. All wires and terminal blocks shall be clearly labeled.
c. Diagram shall be in accordance with NEMA/ICS standards.
2. Size, type and rating of all system components.
3. Unit frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Manufacturer’s product data sheets for all components.

C. Instrumentation/Field Device submittal requirements:
1. Manufacturer’s product data sheets
2. Job-specific model numbers for each instrument/field device
3. Job-specific ranges/setpoints/etc. proposed for each instrument/field device

D. Computer System submittal requirements:
1. Manufacturer’s product data sheets
2. Job-specific model numbers and bill of materials for all computer system devices and software.
3. Screen shots showing proposed layout of each specific or typical SCADA HMI screen.

E. Calculation submittal requirements:
1. Thermal calculations showing amount of air conditioning and heating required for each control panel, per ambient requirements listed below and operating temperature limitations of all equipment/devices within each control panel.
a. Thermal calculations used for sizing cooling systems for each control panel located in exterior or non-conditioned spaces shall assume:
1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.

2) Full solar contact where applicable.
3) No wind.
4) Heat loss from interior equipment (electronics, etc.) per equipment supplier's information.

b. Thermal calculations used for sizing heating systems for each control panel shall assume:
1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.
2) No heat loss by interior components of control panel.
3) No solar gain on exterior of control panel.
4) Doubling of heating wattage required to account for wind where control panels are located outdoors.
5) Minimum temperature difference (due to heating) of 10 degrees F to prevent condensation, regardless of equipment temperature limitations.

2. Load calculations showing the sizing of all power supplies provided (with spare capacity as specified).
3. Load calculations showing the sizing and anticipated runtime of all Uninterruptible Power Supply systems provided (with spare capacity as specified).

1.6. DELIVERY, STORAGE AND HANDLING:

A. Packing and Labeling:
1. Prior to shipment, each component shall be tagged to identify its' location, tag number, and system function. Identification shall be prominently displayed on the outside of the package.
2. Firmly attach permanent, final labeling (as specified elsewhere) to all equipment, panels, instruments/field devices, etc. prior to installation.

B. Delivery:
1. Following completion of shop assembly, factory test, and approval of all equipment by the Engineer, the panels, cabinets, and consoles and equipment shall be shipped. Provide protection for equipment from handling and the environment.

C. Receiving:
1. The contractor is responsible for receiving and proper storage of equipment delivered to the job site.
2. All received items shall be protected from the elements and where required stored in a low humidity environment.
3. Protect materials and equipment against damage in storage and during construction.

PART 2 - PRODUCTS

2.1. GENERAL:

A. Refer to Specification Section 26 29 00 (Manufactured Control Panels) for all control panel enclosure, control component, controller, surge protection device, etc. requirements.
B. Specifications below identify general intent and major system components only. System

Integrator shall be responsible providing all system accessories, interconnections, installation, etc. and verifying compatibility of all system components as required to provide a fully-functional/coordinated system.

2.2. SCADA COMPUTER SYSTEMS

A. SCADA Server – Existing, Owner-Furnished. Provide new SCADA server software as required. Field determine all requirements prior to bid.
B. SCADA Desktop Workstation(s) – Existing, Owner-Furnished two (2) workstations. Provide new SCADA software as indicated below.
C. Provide Interconnecting cabling as required
D. Server Rack Ethernet Switch – Existing, Owner-Furnished.
E. VPN/Security Router – Owner-Furnished/Maintained.

2.3. SCADA SOFTWARE:

A. Provide latest version of Aveva InTouch (formerly “Wonderware”) HMI, Full Development software for one SCADA workstation and Runtime software for other desktop workstations. Tag counts shall be, at a minimum, equal to the required tags plus 50% spare capacity.
B. Provide Aveva InTouch (formerly “Wonderware”) Alarm Notification System/software as required for remote alarm notification as described in Part 3 below.
C. Provide two (2) years of SCADA software vendor support (technical support and product updates) in bid cost.

2.4. EACH SCADA PLC PANEL SHALL INCLUDE:

A. General construction/materials/devices per Specification Section 26 29 00 (Manufactured Control Panels).
B. All printed circuit boards within electronic devices (PLCs, RTUs, controllers, I/O modules, power supplies, touchscreens, Ethernet switches, radios, etc.) installed in panels located in non-conditioned or exterior/process areas shall be conformal-coated for harsh environments.
C. Ethernet Switch:
    1. For PLC Panels with copper Ethernet drops external to panel (such as to workstations, servers, printers field instruments, etc.): provide Managed Industrial Ethernet Switch, with copper ports for all required copper Ethernet connections plus 50% spares and SC-type fiber optic ports for all required fiber optic connections: Rockwell Stratix series or equal by Moxa or NTron.
    2. For PLC Panel with no copper Ethernet drops external to panel (drops only for internal controllers, HMI, laptop ports, etc.): provide Unmanaged Industrial Ethernet Switch, with copper ports for all required copper Ethernet connections plus 50% spares and SC-type fiber optic ports for all required fiber optic connections: Rockwell Stratix series or equal by Moxa or NTron.

D. Fiber optic patch panel(s) as required by application and/or as shown on network diagrams on plans.
E. Controller Devices
    1. Rockwell CompactLogix 5380 series 5069-L340ER processor, 4MB of user memory, 8GB secure digital memory card, (2) integral 10Mbps/100Mbps/1Gbps Ethernet ports, (1) USB client, and chassis and other accessories as required

F. Input/Output modules:
   1. Provide I/O modules on associated controller backplane as required by point lists provided on plans. Spare I/O: A quantity of spare I/O equal to 25% of the quantity specified for the PLC, of each I/O point type, or two of each I/O point type (whichever is greater) shall be provided for each PLC. For example, a PLC with 20 Discrete Inputs, 9 Discrete Outputs and 4 Analog Inputs shall additionally be provided with the following spare I/O: 5 Discrete Inputs, 3 Discrete Outputs, 2 Analog Inputs and 2 Analog Outputs (including spares). This applies to the following I/O point types:
      a. Discrete Input
      b. Discrete Output
      c. Analog Input
      d. Analog Output
   2. Provide network/communication I/O modules (for Ethernet, Profibus, DeviceNet, etc. connections) as required by point lists provided on plans. All networked points listed are representative only. Prior to preparation of submittals, System Integrator shall collect register lists identifying all available networked points for the associated systems from the system supplier(s) and shall review the lists with the owner and engineer for determination of final points to be monitored/controlled. System Integrator shall provide programming/HMI for all networked points chosen by the owner/engineer for these systems.

G. Ambient Air Temperature Transmitter:
   a. Each SCADA PLC shall be provided with an ambient air temperature transmitter (per Specification Section 27 60 05 requirements) factory-mounted to the outside of the PLC enclosure, with engraved nameplate to identify instrument name/tag/function and factory-wired as an analog input to the associated PLC by the SCADA Integrator.

H. Panel-mounted Thin Client PC and Touchscreen (**Required for SCADA PLC-UV only**; NOT required for SCADA PLC-ABLWR, SCADA PLC-DBLWR, or SCADA PLC-DW):
   1. Industrial panel-mounted thin client PC and touchscreen.
   2. Mounted on the deadfront door (outer-most door of panels mounted in dry locations, inner door of panels mounted in exterior locations).
   3. Programming/Screens:
      a. For PLC Panels at treatment facility sites:
         1) Programmed to match appearance/functionality of SCADA workstations
      b. For PLC Panels at remote pumping station and other similar remote sites:
         1) Programmed with screens as required to clearly display and provide control of parameters for the associated station/facility.
   4. Touchscreen:
      a. 19.5” color touchscreen with LED backlight,
      b. NEMA 4X rating,
      c. Rated for operational temperatures of 0 degrees C to 50 degrees C.
      d. HD1080P with 3000:1 contrast ratio
      e. Connectors ars required to coordinate with associated PC/etc.
      f. NEMA 4X stainless steel front mounting bezel
      g. Where located in exterior environments, shall be covered by outer door of panel or fully-collapsible sun shield to fully protect LCD display from UV light when not in use, shall provide side and top shielding when in use. Sun

shields shall be constructed of stainless steel and shall be installed such as to maintain NEMA 4X ratings of enclosures.

h. Hope Industrial HIS-ML19.5-CTTA touchscreen with VB-20A mounting bracket, or equal

5. Industrial PC:
   a. Fanless design.
   b. Rated for operational temperatures of 0 degrees C to 50 degrees C.
   c. 2.1 GHz Dual Core processor with 4GB system memory
   d. Two (2) Mini-DisplayPorts, one (1) GB LAN Ethernet port and four (4) USB 3.0 ports
   e. Logic Supply ML100G-30 PC or equal.
6. Furnished with SCADA HMI and Windows operating system software as required
7. Furnished with wireless/Bluetooth keyboard and optical mouse (stored within pocket within door of PLC), and folding 18”x18” shelf on front of outer door of enclosure (shelf material to match that of enclosure, for example: provide foldable stainless steel shelf for stainless steel panels).

I. Flash-Drive Programming Backup:
   1. Provide portable flash-drive (exact type as required to be easily loadable into panel equipment) mounted to retractable cord hung from inside surface of inner door downloaded with final copies of all programming, etc. for equipment within panel (controller, touchscreen, etc.). Provide engraved nameplate to read: “PROGRAMMING BACKUP”.

J. Communication Equipment:
   1. Fiber-connected PLC Panels:
      a. Provide SC-type fiber-optic ports within Ethernet Switch within PLC panel as required for all required fiber optic connections.
   2. Internet-connected PLC Panels:
      a. Provide copper Ethernet ports within Ethernet Switch within PLC panel as required for internet connections. Ethernet Switch shall be connected to owner’s internet connection as directed.

K. UPS: Provide UPS with battery-supplied power to operate the system for 10 minutes. Refer to Specification Section 26 29 00 for UPS specification requirements.

L. Provide 20A-120V-1Pole grounding-type GFI receptacle within inner door of panel for convenience (laptop charging, etc.). Receptacle shall be connected upstream of UPS power and shall be protected by a dedicated circuit breaker rated for 10A.

M. Panel surge protection, lighting, HVAC, auxiliary components, etc. shall be provided per Specification Section 26 29 00.

2.5. WIRING

A. Refer to Specification Sections 27 05 00, 26 05 19 and 26 29 00 for requirements.

PART 3 - EXECUTION

3.1. GENERAL

A. SCADA System shall:
   1. Measure and monitor discrete and continuous process and process equipment variables (see SCADA Point List on contract plans).

2. Effectively present the process and process equipment variables to the operators allowing them to accurately monitor the status of the processes. Screens/screen shots shall generally be detailed 2 dimensional (with shaded piping, and project-specific side/elevation views of major processes/tanks/equipment).
3. Provide a means for the operators to effectively control the treatment processes, both automatically and manually.
4. Provide historical data acquisition, storage, retrieval, processing, and report generation.

B. The SCADA software shall be developed to include graphics for the proposed project scope. Human-Machine Interface (HMI) software as specified shall be supplied and fully configured by the System Integrator. Reports, graphics displays, real-time trends, function blocks, PID loop control, historical trends, security, alarming, etc. shall be developed by the System Integrator through a collaborative effort between the Engineer, Owner, Contractor and Equipment Suppliers.

C. This system shall allow owner to securely monitor and control the facility via internet (from the referenced owner-furnished workstations/laptops) using industry-standard Internet security and automatic server failover. Displays on remote workstations/laptops shall appear exactly as they do on standard, hardwired thick-client workstations without further configuration.

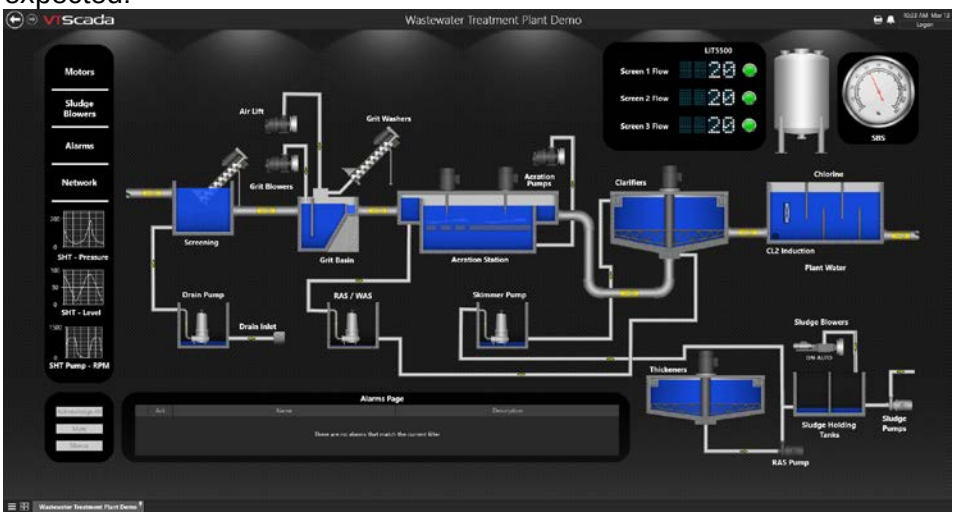
D. The system shall include all provisions as necessary to allow SCADA Integrator to remotely monitor the system and to remotely make software/configuration repairs/improvements/updates to the system. Include modifications or additions to facility networks (in collaboration with owner's IT personnel) as required to provide VPNs or SSNs with industrial firewalls as required for secure network access to the SCADA systems. Entire installation shall be fully compliant with applicable sections of the latest version of ISA/IEC standard 62443 and all recommendations/standards of the PLC, Ethernet switch, and computer system manufacturers for proper cybersecurity. Minimum security provisions shall include, but not be limited to, 2-Factor Authentication, data encryption, strict firewall rules, automated security patch updates, etc. as recommended by ISA 62443 or as required by owner's IT personnel. The SCADA Integrator shall plan a meeting with the owner's IT personnel to review the proposed cybersecurity requirements and provisions prior to submitting system shop drawings.

E. The system shall include all provisions as necessary to provide alarm notification to off-site personnel. The system shall be configured to provide customizable alarm information via text-to-voice phone calls, SMS text messages, emails or pagers as directed/approved by the facility owner. The alarming system shall cascade alarms through a user-editable list of contacts, allowing each user to acknowledge the alarm (and to stop further notifications to other contacts).

F. In general, the operator interface to the system shall be via a hierarchy of graphics screens with "poke points" which will allow operators to navigate the plant facility by facility by simply "clicking" on the poke points with a mouse pointing device. All HMI conventions/graphics shall meet owner's standards/conventions. Integrator shall fully review proposed screen conventions with owner prior to submitting screen submittals.
1. A "Main Menu" shall be developed and will contain "poke points" to allow navigation to the following major subsystems:
    a. Overall detailed 2-D graphical screen of site(s), showing major structures/processes. Screen(s) shall show shaded piping, and project-specific side/elevation representations of the various equipment/facilities. Screen(s) shall indicate major system parameters such as significant

flow/level measurements, system on/off statuses, etc. in a clear manner, but shall not be used for detailed parameter displays.

b. One (1) overall system process-flow diagrammatical representation of major process system or structure, on one screen if possible (with detailed 2-D graphics for each major structure or process). Screen(s) shall indicate major system parameters such as significant flow/level measurements, system on/off statuses, etc., but shall not be used for detailed parameter displays. Recent historical trends of major applicable analog variables should be displayed in graph form, either embedded within the associated facility/tank, or on a sidebar, per owner preferences. Below is a general/typical example of the quality of overall process-flow screen expected:



Typical Example: Overall Process Flow Screen

c. Separate process-flow diagrammatical representations (with detailed 2-D graphics for each component) for each major process or structure. Screens shall indicate all relevant I/O statuses, and shall allow for control for the given process or structure.

d. Pop-up style detailed component or process screens (for individual VFDs, analog instruments, PID or setpoint control systems, etc.). These types of component screens shall rely on graphical/diagrammatical displays rather than just text where possible.

e. Real-time trend displays.

f. Historical trend displays.

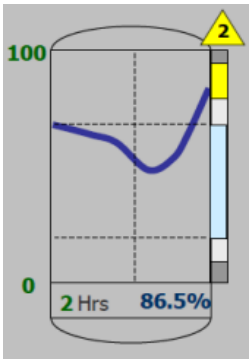
g. Excel reporting subsystem.

h. I/O diagnostics test displays.

i. Current alarms.

j. Equipment maintenance subsystem.

2. Where possible, real-time trends shall be embedded into the process-flow diagrammatical representations noted above. For example, graphical displays showing tank levels shall include an embedded trend line (within the tank image) to indicate the historical trend for the tank level. Typical/acceptable ranges and alarm ranges should be graphically indicated (by horizontal lines or colored bars as selected by owner) on the trend so that the user can quickly determine if the associated trend is within acceptable range(s). Similar embedded trending graphics shall be provided for other analog values where helpful to the plant operator. Below is a general example of this type of embedded trending:



Typical Example: Embedded Trending

3. The “Main Menu” shall contain dynamic symbols to depict the operational/communications status of each SCADA System panel/network device on the network (i.e. Normal or In Communications Failure).
4. Each new graphic display shall be designed so that an operator may “click” on “poke points” to gain access to any area of the facility (or to remote systems, where applicable) or to the Main Menu. The operator shall also be able to access the Current Alarms Display from any graphic display. Real-time and Historical Trend displays shall be made available from each plant process area via poke points.
5. All new graphics displays of plant areas shall be based upon detailed 2-D graphics as a basis for the display unless noted otherwise. For example, piping shall generally be drawn as grey-scale 2D pipes with fading (from center of pipe to outside edge of pipe), and with flow direction arrows. Motors, pumps, equipment images, etc. shall include similar detail.
6. Color conventions (for ON, OFF, OPEN, CLOSED, and various levels of alarms) used within the HMI shall be per the owner’s standards (to be determined during the construction phase of the project). Consideration should be given to simplifying the color schemes by using bolder colors for alarm conditions than for typical running/off/open/closed conditions.
7. Screen background color (black, grey, white, etc.) shall be as selected by owner. Consideration shall be given to black background color to minimize screen brightness for night operators.
8. Special graphics displays shall be developed by the System Integrator for each process control strategy. These graphics displays shall allow authorized operators to modify control parameters such as set points, operational sequences, etc. Passwords shall be utilized to determine the authorization level of operators.
9. All process alarms shall be categorized by “group” with each group representing a specific area of the plant or distribution system.
10. Security of the system shall be accomplished via allowing access to various parts and features of the system via entry of User names and passwords.
11. Graphics screens shall be developed for each major item of process equipment for which equipment runtime or equipment maintenance data is being collected. These graphics screens shall contain all data relative to the piece of equipment including runtime today, runtime since last serviced, total runtime between maintenance intervals. All runtime data shall be maintained by the various programmable logic controllers; not by the HMI software package.

12. All historical process data, such as average flows, hourly minimums and maximums, etc., shall be maintained by the various programmable logic controllers; not by the HMI software package.

3.2. TESTING

A. General
   1. All elements of the hardware and software shall be tested to demonstrate that the total system satisfies all of the requirements of this specification.
   2. As a minimum the testing shall include the following:
      a. Unwitnessed Factory Test (UFT)
      b. Factory Demonstration Test (FDT)
      c. Operational Readiness Test (ORT)
      d. Functional Acceptance Test (FAT)
   3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsection's producing the correct result (effect), the specific test requirement will have been satisfied.

B. Unwitnessed Factory Test (UFT)
   1. Prior to start of the witnessed Factory Demonstration Tests, the entire system shall be inspected and tested at the system supplier's factory to ensure that it is fully operational and ready for demonstration testing.
   2. All panels, consoles and assemblies of the System shall be inspected and tested to verify that they are in conformance with related submittals and these specifications.

C. Factory Demonstration Test (FDT)
   1. The System Integrator shall schedule a witnessed Factory Demonstration Test with the owner and project engineers. The exact date of the FDT shall be scheduled in coordination with the owner and engineers a minimum of two (2) weeks in advance.
   2. The entire SCADA System shall be tested at the System Integrator’s factory in the presence of the owner and engineers to demonstrate that it is operational and in conformance with these specifications.
   3. Tests shall demonstrate specified functions, both hardware and software, including display of anticipated screen shots, to the satisfaction of the owner.

D. Operational Readiness Test (ORT)
   1. General: Prior to start-up, the entire installed System shall be certified (inspected, tested and documented) that it is ready for operation. These inspections and tests shall include Loop/Component Inspections and Tests and a repeat of the Factory Demonstration Tests.

E. Functional Acceptance Test (FAT)
   1. The entire SCADA System shall be tested on-site to demonstrate that it is operational and in conformance with these specifications.
   2. Tests shall demonstrate specified functions, both hardware and software, to the satisfaction of the owner.

3.3. TRAINING

A. General

1. Provide an integrated training program for the owner's personnel at the jobsite. Tailor the training program to meet the specific needs of the Owner's personnel. Include training sessions, classroom and field, for managers, engineers, operators and maintenance personnel.
2. The training shall be carried out by technically competent and experienced instructors
3. The Owner shall have the right to make and reuse video tapes of all of the onsite training sessions.
4. One eight (8) hour day shall be provided on site for owner and or engineer selected attendees.

END OF SECTION 27 60 00

SECTION 27 60 05 - SCADA INSTRUMENTATION

PART 1 - GENERAL

1.1. DESCRIPTION

A. General Note: While this specification is primarily written for SCADA Instrumentation, it shall also apply to all BNR/Aeration System instrumentation (as required by specification section 44 42 13).

B. Work included: Provide a complete system of instrumentation and controls with appurtenant equipment and accessories as indicated, specified, and as necessary for a complete and proper operating system.
   1. Work includes, but not necessarily limited to, the following:
      a. All engineering, hardware and software development, installation, startup, ranging, calibration services and supervision necessary.
      b. Testing and operational demonstrations as specified.
      c. Training programs as specified.
      d. Preparation of manuals.

C. Related work:
   1. Documents affecting work of this Section include, but are not necessarily limited to, General Specifications, Special Provisions, and all other related Sections.
   2. Refer to Specification Section 27 60 00 for additional SCADA System requirements.
   3. Refer to plans for point lists and additional device requirements.

1.2. QUALITY ASSURANCE

A. Where not specifically allowed or required otherwise by contract documents, all instrumentation and related equipment specified within this section shall be furnished by the SCADA Integrator for the project for proper system coordination.

B. Contractor:
   1. Shall be fully and solely responsible for the work of the systems supplier and solely responsible to the Owner for having supplied to the Owner the complete integrated SCADA system.
   2. To provide personal superintendence and direction of the work, maintaining and supplying complete supervision over and coordination between all subcontractors employed by him and the Instrumentation and Control System Integrator.
   3. To be responsible for defining the limits of his subcontractor's work.
   4. To be responsible for setting of instruments (including alarms, etc. as provided under other sections).

C. Provide Operation and Maintenance manuals
   1. Operating instructions shall incorporate a functional description of the entire system, including the system schematics which reflect “as-built” modifications.
   2. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.
   3. As part of the operation and maintenance manuals, provide one hard copy of the program used to program the programmable logic controller.

1.3. WARRANTY

A. Systems supplier shall furnish a hardware and software warranty for the system starting at substantial completion and ending one year from this date.

1.4. REFERENCES

A. Instrument Society of America (ISA) PR7. 1, Pneumatic Control Circuit Pressure Test, Tentative Recommendation Practice.
B. Instrument Society of America (ISA) S5.4, Instrument Loop Diagrams, standard.
C. National Electrical Manufacturers Association (NEMA) Publication, General Standards for Industrial and Control Systems, ICS 1 and Industrial Controls and Systems ICS2.

1.5. SUBMITTALS

A. General/System submittal requirements:
    1. Provide submittal (quantity as required by contract) of:
        a. Component manufacturing data sheets indicating pertinent data and identifying each component (including all instruments, surge protection devices, antennae, sun/rain shields, etc.) by tag number and nomenclature as indicated on drawings and in specifications.
        b. Component drawing showing dimensions, mounting, and external connection details,
        c. List of all spare parts. All manufacturers recommended spare parts shall be provided in addition to required spare parts.
    2. Identify any specification section where exceptions are being taken or an "or equal" piece of hardware is being proposed.
    3. A Bill of Materials shall be included with catalog information on all components.
    4. Information shall be included on any proprietary logic component sufficient to demonstrate its ability to perform the required functions.

B. Instrumentation/Field Device submittal requirements:
        a. Manufacturer’s product data sheets
        b. Job-specific model numbers for each instrument/field device
        c. Job-specific ranges/setpoints/etc. proposed for each instrument/field device

1.6. DELIVERY, STORAGE AND HANDLING:

A. Packing and Labeling:
    1. Prior to shipment, each component shall be tagged to identify its' location, tag number, and system function. Identification shall be prominently displayed on the outside of the package.
    2. Firmly attach permanent stainless-steel, or other durable non corrosive tag to the equipment. Mark tags with the instrument tag number shown in the Instrumentation Data Sheets and/or Instrument drawings.

B. Delivery:
    1. Following completion of shop assembly, factory test, and successful submittal of all equipment information (without requirement for resubmittal), equipment shall be shipped. Provide protection for equipment from handling and the environment.

C. Receiving:
    1. The contractor is responsible for receiving and proper storage of equipment delivered to the job site.

2. All received items shall be protected from the elements and where required stored in a low humidity environment.
3. Protect materials and equipment against damage in storage and during construction.

PART 2 - INSTRUMENTATION

2.1. GENERAL

A. All equipment and materials shall be new, unused and proved by previous use of similar products to be completely suitable for the service intended.
B. All of the equipment shall be the manufacturer's latest and proven design. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the system. All accessories, hardware, etc. shall be provided as required for a fully functional system. The completed system shall be compatible with the functions required and other equipment furnished by the Contractor.
C. All electrical components of the system shall be powered by 120V, single phase, 60 cycle current or 24VDC loop-powered from control panel, except as otherwise indicated or specified.
D. Cable lengths between sensors/elements and associated transmitters shall be as required by application. Contractor shall coordinate lengths and types of all sensor cables with the associated sensor supplier prior to bid and shall provide cable lengths/types as required.
E. The part numbers provided below identify the major parts only. Provide additional options/accessories/hardware/etc. as required for a complete system.

2.2. UNIVERSAL CONTROLLERS/SINGLE OR MULTI-PARAMETER TRANSMITTERS

A. General:
    1. All new universal controllers/multi-parameter transmitters on the project shall be of the same type by the same manufacturer, unless specifically directed otherwise.
    2. All universal controllers/multi-parameter transmitters shall be of the same manufacturer as the proposed associated sensors, with options/accessories as required to coordinate with the proposed associated sensors.

B. Technical Specifications:
    1. Single or multi-parameter analyzer/transmitter, with:
        a. Interface unit allowing operators to control sensor and transmitter functions with menu-driven software.
        b. Built-in data logger with capacity to store data on 15 minute intervals for up to six months with two sensors per controller.
        c. Two independent PID control functions
    2. Capable of analyzing/transmitting signals from any of the following digital or analog sensor types:
        a. Ammonia
        b. Chlorine
        c. Chlorine Dioxide
        d. Conductivity
        e. Dissolved Oxygen
        f. Flow

g. Nitrate
h. Oil in Water
i. Organics
j. Ozone
k. pH/ORP
l. Phosphate
m. Phosphorous
n. Sludge Level
o. Suspended Solids
p. TOC
q. Turbidity
r. 4-20mA Input

3. NEMA 4X, IP66 corrosion resistant enclosure.
4. 120VAC, 60Hz Power Input.
5. Display:
   a. Integral large color touchscreen display touchpanel
6. Transmitter Outputs:
   a. Analog Outputs:
      1) Up to five (5) 4-20mA (Hart)
   b. Four (4) Form C SPDT relays
   c. Profibus DP digital communication
7. -20-60 degrees C temperature rating unless specifically noted otherwise.

C. Execution:
   1. Setup/calibrate with associated sensors as required. Mount with corrosion-resistant mounting hardware as required by application.
   2. Provide full two (2) year warranty from manufacturer.

D. Acceptable manufacturers: Hach #SC4500 series (for up to five 4-20mA outputs).

2.3. LEVEL (OR OPEN CHANNEL FLOW) TRANSMITTERS & ULTRASONIC TRANSDUCERS

A. General:
   1. Scope -This section describes the requirements for a 4-wire, multi-functional ultrasonic level/open channel flow transmitter system.
   2. Basic System Description
      a. The multi-functional level control system (level system) shall employ acoustic echo-ranging technology to determine the distance between the transducer(s) and monitored surface(s), as a basis for display, output, and digital communication.
      b. The level/flow monitoring system shall consist of a microprocessor based level transmitter and one or two ultrasonic transducers.
      c. The level/flow transmitter shall be operator configurable to meet specific application requirements by implementation of available signal processing and process control functions, in any allowable combination.

B. Technical Specifications:
   1. Signal Processing - The level transmitter shall:
      a. Employ ultrasonic transceiver(s) suitable for providing excitation to, and processing resultant signals from the attached ultrasonic transducer(s).

b. Create a digitized echo profile, and apply patented Sonic Intelligence echo processing techniques to select and verify the echo representing the reflective surface monitored.
c. Calculate the distance between the transducer face and reflective surface based on the echo selected. The calculated distance may be converted to represent: material level, differential level, average level, space, material volume, vessel ullage, pumped volume, or head, open channel flow rate, and/or total flow volume.
d. Compensate temperature-induced variation in the acoustic wave propagation velocity in air. This compensation shall be based on signals received from the ultrasonic transducer(s) and/or a TS-3 temperature sensor.
e. Include a calibration method and/or enable manual operator value entry, to set a fixed acoustic wave propagation velocity for transmission mediums other than air.
f. Include configuration and calibration ability via integral keypad with non-volatile EEPROM memory to store user-programmed configuration.
g. Display measured variable (level/flow) on the main backlit LCD display along with associated units.

2. Process Control Functions - The level transmitter shall provide an assortment of process control functions that may be user implemented in any allowable combination.
   a. Standard Process Control Functions
      1) 0/4–20 mA output directly / inversely proportional to level, space, flow or distance
      2) Level alarm(s) based on on/off setpoints
      3) Loss of Echo or Cable Fault alarm
      4) Duty assist pump operation based on fixed or alternating level setpoints
      5) Remote relay state control via communications
      6) Basic failsafe operation on measurement loss
      7) Discrete inputs configurable to override level transmitter I/O operations
3. User Interface - The level transmitter shall enable user access to read only and read/write enabled data, using any of the following methods:
   a. Direct or scroll access to data stored in numerical parameters, using the hand programmer and graphic LCD display.
   b. IBM PC compatible computer access to data and digital echo profiles, using the Dolphin Plus instrument configuration package.
   c. HMI, SCADA, PLC, or DCS system access to data stored in Modbus registers via digital communications.
4. Detailed Specifications:
   a. Power
      1) 100-230 VAC ± 15%, 50 / 60 Hz, 50VA or less
   b. Enclosure
      1) Polycarbonate/Polyester, Indoor/Outdoor
      2) NEMA 4X / IP 65
   c. Ambient Temp.
      1) -20 to 50°C (-5 to 122°F)
   d. Display
      1) Back lit LCD, multi-line display
   e. Process Control I/O - The level transmitter shall provide:

1) One (1) 4-20mA HART analog signal output, directly or inversely proportional and scalable to the configured process variables, (dependent upon the transmitter model), capable of driving a 750 ohm load.
2) A minimum of three (3) form C relays with contact outputs based on the level conversion or other process variable as set by the Relay Function and other user configurable relay parameters.
3) Two discrete inputs that may be configured to override normal Process Control Functions.
4) One (1) 4-20mA input (model dependant) that may be scaled to a monitored process variable, to be used as a basis for level transmitter Process Control Functions.

f. Ranges: As directed by Civil Engineer.

5. Accessories:
   a. Stainless steel mounting bracket/hardware as recommended by manufacturer.
6. Spare Parts:
   a. Provide one (1) spare transducer of each type furnished with manufacturer's cable length to match longest cable length furnished within project.
7. Execution:
   a. Maintain minimum separation between transducer and maximum process material level as recommended by manufacturer.
   b. Mount transducer to ensure a clear path from the transducer to the process material surface.
   c. Where required by the application, provide submergence shield for the transducer(s).

C. Manufacturer/ Model:
   1. Siemens Hydroranger 200 HMI series transmitter with Echomax XRS series Ultrasonic Level Transducer(s) as required by application.
   2. Equal by Endress + Hauser

2.4. SUBMERSIBLE PRESSURE (HYDROSTATIC) TRANSDUCERS

A. General:
   1. Scope -This section describes the requirements for a 2-wire submersible pressure/level transmitter system.

B. Standard specifications:
   1. Submersible hydrostatic level transducer with integral diaphragm protector
   2. 2-wire 4-20mA loop powered
   3. Waterproof housing constructed of 316 stainless steel
   4. Attached electrical cable with Kevlar strength membes
   5. Class I, Division I rated.

C. Execution:
   a. Terminate vented transducer cable in aneroid bellows in NEMA 4X stainless steel box mounted above associated wetwell in accordance with all applicable NFPA 820 requirements and as recommended by manufacturer.

b. Hang/support transducer/cable assembly from stainless steel cable hanger at height as directed by Civil Engineer

D. Manufacturer/ Model:
1. KPSI 750 series Submersible Level Transducer(s) (with integral diaphragm protector) with the following accessories:
a. Anti-Snag Cone
b. Stainless steel cable hanger
c. Aneroid Bellows
d. Full Lightning Protection with Lifetime Lightning Protection

2.5. TEFLON-COATED STAINLESS STEEL FLOAT SWITCHES

A. Standard Specifications:
1. Teflon-coated stainless steel body
2. Mercury-free magnetic reed SPST switch rated for 100VA at up to 250V. N.O. or N.C. contacts shall be as indicated on wiring diagrams or required by application, coordinated by contractor and equipment supplier.
3. Non-oxidizing contacts
4. Complete with factory-installed CPE jacketed cable designed for heavy flexing service with neoprene sleeves for cable stress relief, length as required to be extended to contractor-furnished termination point.
5. Provide stainless steel cable suspension kit (length as required by application) with 15 pound anchor, wall bracket and cable clamps as required, unless noted otherwise.

B. Execution:
1. Install float switches at heights as directed by civil engineer at locations that do not risk damage to the float switches.
2. Contractor shall provide corrosion resistant junction box or other termination point above high water level for splicing cables furnished with float switch(es) to cables furnished by contractor. Provide cord connectors at base of junction box (or similar) and stainless steel Kellems cord grips for proper strain relief of all float switch cables.

C. Manufacturer/ Model: Siemens #9G-EF with hardware/accessories as described above, or equal. Normally-open/normally-closed contact types shall be coordinated by supplier and shall be as required by application.

2.6. ELECTROMAGNETIC FLOW METER ELEMENT & TRANSMITTER

A. General:
1. Basic System Description
a. The system shall employ an in-line electromagnetic flow meter with remote 4-wire transmitter. Under this item, the contractor shall furnish and install the system, and all associated equipment and accessories as required for a complete installation.

B. Technical Specifications:
1. Process Control I/O - The flow transmitter shall provide:
a. One analog signal output, directly or inversely proportional and scalable to the configured process variable, (dependent upon the controller model).

2. Process Control Functions - The flow transmitter shall provide an assortment of process control functions that may be user implemented in any allowable combination, limited by the process control I/O capabilities of the level controller model and variation.
    a. Standard Process Control Functions
        1) 4–20 mA output directly / inversely proportional to flow
        2) Basic failsafe operation on measurement loss
3. User Interface - The flow transmitter shall enable user access to read only and read/write enabled data, using any of the following methods:
    a. Direct or scroll access to data stored in numerical parameters, using the hand programmer and graphic LCD display.
4. Detailed Specifications:
    a. Power: 120 VAC , 60 Hz,
    b. Enclosure: Polycarbonate, NEMA 4X / IP 65
    c. Ambient Temperature Rating: -20 to 50°C (-5 to 122°F)
    d. Transmitter Display: Back lit LCD
    e. Outputs:
        1) One (1) 4-20 mA Hart, directly or inversely proportional, scalable and configurable, 750 ohm maximum load, isolated, +/- 0.1% resolution
        2) One (1) pulse output.
        3) Two (2) digitally-configurable discrete inputs/outputs rated for 2 watts at 28VDC.

C. Execution:
1. Install sensor as required to maintain minimum upstream/downstream straight piping sections recommended by the manufacturer.
2. Provide grounding accessories and installation as recommended by the manufacturer for the application.
3. Where discrete inputs/outputs at the transmitter are utilized, provide interposing relays with Form C contacts (connected to the applicable inputs/outputs) within stainless steel j-box below the transmitter. Provide 24VDC power source (with all circuitry as required) to the transmitter/relays as required to power the relays inside the transmitter.

D. Manufacturer/ Model: Rosemount #8750WD-M-W-1-A-1-F-*-*-B-*** remote-mount transmitter with in-line flow sensor with diameter, liner, grounding electrodes, flange types/ratings, etc. as required for application or recommend by manufacturer, or equal by ABB or Endress + Hauser.

2.7. INSERTION TYPE THERMAL DISPERSION AIR FLOW ELEMENT WITH REMOTE TRANSMITTER

A. Construction – Flow Element
1. Connection Type: Male NPT Stainless Steel
2. Type: Insertion Thermal Dispersion
3. Body Material: 316 Stainless Steel with Adjustable Teflon Ferrule
4. Sensor Material: Hastelloy C
5. Temperature Range: 4 to 37 Degree C
6. Accuracy: +/- 1.0% of upper range value
7. Pressure Range: As required by application.

B. Construction – Transmitter

1. Casing: NEMA 4X Cast Aluminum, Epoxy Coated
2. Mounting: Remote
3. Power: 24VDC
4. Output: 4-20 mA
5. Display Type: LCD (rate) in engineering units (scfm)

C. Execution:
1. Install sensor as required to maintain minimum upstream/downstream straight piping sections recommended by the manufacturer.
2. Install into process piping in accordance with manufacturer's recommendations.
3. Provide flow conditioner as required to condition the airflow through the flow transmitter for more accurate flow measurements.

D. Manufacturer/ Model: FCI ST50 series with VORTAB flow conditioner.

2.8. GAUGE PRESSURE TRANSMITTERS

A. Standard specifications:
1. NEMA 4X, corrosion resistant polyurethane-covered aluminum enclosure.
2. Provided with integral 2-valve manifold for isolation, venting, draining or calibration.
3. Provided with diaphragm or flanged annular seals (by Red Valve or equal) where in contact with process fluids other than clean water or air. Diaphragms and/or seals shall be factory-installed and factory-calibrated by the supplier of the seal or pressure transmitter prior to delivery to project site.
4. 24vdc loop powered
5. Integral digital LCD display
6. Transmitter output 4-20 mA
7. Accuracy +/- 0.2% Span
8. Stability +/- 0.25% Upper Range Limit.
9. Local adjustments – zero and span
10. Overrange and overload protection
11. 316 SS diaphragm
12. Glass-filled PTFE O-Ring
13. Silicone fill fluid

B. Execution:
1. Where in contact with clear water or air:
a. Shall be connected to process piping with flexible stainless steel impulse piping such as to limit transmission of vibration to device as directed by civil engineer unless specifically shown otherwise.
b. Impulse piping shall be as short as possible and shall slope at least 1 in./foot upward from the transmitter toward the process connection.
2. Where in contact with other fluids:
a. Diaphragm seals shall be installed onto process piping or vessel as per manufacturer's recommendations.
b. Flanged annular seal shall be installed in-line within process piping as per manufacturer's recommendations.
c. Contractor shall coordinate installation (and insertion into or connection to process piping or vessel) with associated piping or vessel prior to ordering materials.

C. Acceptable manufacturers: Rosemount 3051CG series

2.9. AMMONIA ANALYZERS AND REMOTE TRANSMITTERS

A. Standard specifications:
   1. Transmitter:
      a. Hach SC4500 as specified above.
   2. Analyzer/Sensor(s):
      a. Hach Amtax sc analyzer #6157400
      b. Sensor Cables: Integral, length as required by application, terminated with quick-disconnect plug. Provide 120VAC power to analyzer from associated transmitter 120V power source.
      c. Sample System: Provide Hach Filtrax #5739000 Filtered Water Sample System for each group of ammonia/phosphorous analyzers as recommended by instrument supplier. Provide all interconnections as required for a complete, fully-functional system.
      d. Mounting:
         1) Handrail-mounted as directed by civil engineer.

B. Execution:
   1. Install sample line into process liquid at exact locations as directed by Civil Engineer and recommended by equipment supplier. Mount analyzer above process level with corrosion-resistant hardware as required by application and per owner standards.

2.10. AMMONIUM IMMERSION/SUBMERSION SENSORS AND REMOTE ANALYZERS/TRANSMITTERS

A. Standard specifications:
   1. Transmitter/Analyzer:
      a. Hach SC4500 as specified above.
   2. Sensor(s):
      a. Hach A-ISE #LVX440.99.10002 ammonia immersion probe
      b. Sensor Cable: Integral, length as required by application, terminated with quick-disconnect plug
      c. Mounting:
         1) Immersion Type: Furnish corrosion-resistant probe-mounting hardware as directed by civil engineer.

B. Execution:
   1. Install sensors into process liquid at exact locations as directed by Civil Engineer and recommended by equipment supplier, with hardware as required by application and per owner standards.

2.11. D.O. (DISSOLVED OXYGEN) IMMERSION/SUBMERSION SENSORS AND REMOTE ANALYZERS/TRANSMITTERS

A. Standard specifications:
   1. Transmitter/Analyzer:
      a. Hach SC4500 as specified above.
   2. Sensor(s):

a. Hach LDO-2 sc Model 2 immersion probe, with Luminescent DO technology (no air blast cleaning system).
b. Sensor Cable: Integral, length as required by application, terminated with quick-disconnect plug
c. Mounting: Furnish handrail-mounting assembly (from probe supplier) including 1 ½" CPVC pole (length as required by application) with corrosion-resistant swivel/pivot/pipe clamp hardware.

B. Execution:
1. Install sensors into process liquid at exact locations as directed by Civil Engineer and recommended by equipment supplier, with corrosion-resistant, handrail-mounted hinged pipe hardware as required by application and per owner standards.

2.12. NITRATE IMMERSION/SUBMERSION SENSORS

A. Standard specifications:
1. Transmitter/Analyzer:
a. Hach SC4500 as specified above.
2. Sensor(s):
a. Hach NT3100sc UV Nitrate Sensor #LXV449.99.11001
b. Sensor Cable: Integral, length as required by application, terminated with quick-disconnect plug
c. Mounting: Furnish handrail-mounting assembly (from probe supplier) including 1 ½" CPVC pole (length as required by application) with corrosion-resistant swivel/pivot/pipe clamp hardware.

B. Execution:
1. Install sensors into process liquid at exact locations as directed by Civil Engineer and recommended by equipment supplier, with corrosion-resistant, handrail-mounted hinged pipe hardware as required by application and per owner standards.

2.13. O.R.P. (OXIDATION REDUCTION POTENTIAL) IMMERSION/SUBMERSION SENSORS

A. Standard specifications:
1. Transmitter/Analyzer:
a. Hach SC4500 as specified above.
2. Sensor(s):
a. Hach pHD sc ORP immersion probe
b. Sensor Cable: Integral, length as required by application, terminated with quick-disconnect plug
c. Mounting: Furnish handrail-mounting assembly (from probe supplier) including 1 ½" CPVC pole (length as required by application) with corrosion-resistant swivel/pivot/pipe clamp hardware.

B. Execution:
1. Install sensors into process liquid at exact locations as directed by Civil Engineer and recommended by equipment supplier, with corrosion-resistant, handrail-mounted hinged pipe hardware as required by application and per owner standards.

2.14. PHOSPHOROUS ANALYZERS AND REMOTE TRANSMITTERS

A. Standard specifications:
   1. Transmitter:
      a. Hach SC4500 as specified above.
   2. Analyzer/Sensor(s):
      a. Hach Phosphax sc phosphate analyzer #6159600
      b. Sensor Cables: Integral, length as required by application, terminated with quick-disconnect plug. Provide 120VAC power to analyzer from associated transmitter 120V power source.
      c. Sample System: Provide Hach Filtrax #5739000 Filtered Water Sample System for each group of ammonia/phosphorous analyzers as recommended by instrument supplier. Provide all interconnections as required for a complete, fully-functional system.
      d. Mounting:
         1) Handrail-mounted as directed by civil engineer.

B. Execution:
   1. Install sample line into process liquid at exact locations as directed by Civil Engineer and recommended by equipment supplier. Mount analyzer above process level with corrosion-resistant hardware as required by application and per owner standards.

2.15. T.S.S. (TOTAL SUSPENDED SOLIDS) SENSORS AND REMOTE ANALYZERS/TRANSMITTERS

A. Standard specifications:
   1. Transmitter/Analyzer:
      a. Hach SC4500 as specified above.
   2. Sensor(s):
      a. Hach TSS W sc #LXV324.99.10002 immersion probe with wiper, stainless steel
      b. Sensor Cable: Integral, length as required by application, terminated with quick-disconnect plug
      c. Mounting:
         1) Immersion Type: Furnish handrail-mounting assembly (from probe supplier) including 1 ½" CPVC pole (length as required by application) with corrosion-resistant swivel/pivot/pipe clamp hardware.
         2) Insertion Type: Provide tri-clamp insertion probe. Mount within process piping as directed by civil engineer.

B. Execution:
   1. Install sensors into process liquid at exact locations as directed by Civil Engineer and recommended by equipment supplier, with hardware as required by application and per owner standards.

2.16. AMBIENT AIR TEMPERATURE TRANSMITTERS

A. Interior/Dry Locations:
   1. Standard Specifications:
      a. Panel-mounted to panel exterior (where on control panel/PLC panel), or outlet-box mounted.

b. 1000 Ohm platinum RTD
c. With integral transmitter for 4-20mA loop-powered output (2-wire instrument)
d. Display: 4 Digit LED
e. Labeling: Supplier/integrator shall provide engraved nameplate to read “AMBIENT TEMPERATURE TRANSMITTER”
f. Housing: Splash resistant faceplate with rear gasket seal
g. Temperature Range: -40 to 180 degrees F (scaled to 4mA = -13 degrees F and 20mA = 167 degrees F)
h. Accuracy: ±0.5 ºF (±0.3 ºC) at 77 ºF (25 ºC)

2. Acceptable Manufacturers: Devar d-RTTI

B. Wet/Process/Exterior Locations:

1. Standard Specifications:
   a. NEMA 4X enclosure
   b. 1000 Ohm platinum RTD
   c. With integral transmitter for 4-20mA loop-powered output (2-wire instrument)
   d. Display: 4 Digit LED
   e. Labeling: Supplier/integrator shall provide engraved nameplate to read “AMBIENT TEMPERATURE TRANSMITTER”
   f. Housing: Splash resistant faceplate with rear gasket seal
   g. Temperature Range: -40 to 180 degrees F (scaled to 4mA = -13 degrees F and 20mA = 167 degrees F)
   h. Accuracy: ±0.5 ºF (±0.3 ºC) at 77 ºF (25 ºC)
2. Acceptable Manufacturers: Devar d-RTTI-N4

2.17. PORTABLE DOCUMENTING HART PROCESS CALIBRATOR

A. Standard specifications: Furnish one (1) calibrator (of type specified below) to the owner, complete with (all part numbers are by Fluke):
   1. CXT1000 Extreme Hard Carrying Case
   2. Differential Pressure Module of type suitable for the applications installed within the project or within the owner’s other equipment.
   3. Three (3) sets of TP220 test probes.
   4. Two (2) sets of AC 280 hook clips
   5. Two (2) sets of TL224 industrial test leads
   6. DPC/TRACK Sample Software
   7. NIST-traceable calibration report and data
   8. Instruction manual
   9. Battery pack with charger.

B. Execution: Furnish calibrator to owner and train owner in proper operation during the instrument calibration process.

C. Acceptable manufacturers Fluke 754

2.18. SUN/RAIN SHIELDS

A. General:
   1. Sun/Rain Shields shall be:
      a. Furnished for all instruments that will be exposed to sun or rain (or where otherwise specifically noted).

b. Furnished by instrumentation supplier.

B. Standard Specifications:
1. Unless specified otherwise, sun/rain shields shall:
a. Have minimum dimensions of 24” wide X 24”high X 6” projection past front of associated instrument. Sun/Rain shields shall be sufficiently sized to accommodate instrument(s) plus associated surge protection device(s), power supplies, and other similar devices.
b. Have top and sides formed of single sheet 10 gauge aluminum.
c. Have back formed of single sheet 10 gauge aluminum tack-welded to top and sides to form a waterproof connection.
d. Have all exposed corners and edges grounded to be smooth and round.

C. Execution:
1. Sun/rain shields shall:
a. Be mounted corrosion resistant stainless steel mounting hardware
b. Include hardware as required to provide a minimum of ¾” separation between instrument (and other similar devices) and back of sun/rain shield.
c. Be mounted to wall, handrail, pipe or other similar supporting structure.

2.19. ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. General
1. Function: Protect the system against damage due to electrical surges.

B. Application: As a minimum, provide surge and transient protection (with proper grounding) at all field instrumentation connected to process piping or where part of circuitry extends outside building(s), as described below:
1. Analog Instruments::
a. Provide surge protection device(s) at power and analog circuit connections to the instrument equipment.
b. At 2-wire, loop-powered instruments, surge protection device shall:
1) Be of stainless steel, pipe-mounted, IP67 construction, nipple-mounted at the instrument as directed by the device supplier.
2) Have 10kA total nominal discharge current per line (based on 8/20µs waveform).
3) Have maximum continuous operating voltage (MCOV) rating as required by the associated signal.
4) Be Dehn DEHNpipe series or equal by MTL Technologies.
c. At 4-wire, separately-powered instruments, surge protection device(s) shall:
1) Be mounted within one (1) appropriately-sized NEMA 4X enclosure with viewing window at the field device.
2) Be of DIN-rail mountable construction.
3) Have 10kA total nominal discharge current per line (based on 8/20µs waveform) for the analog signal.
4) Have 15kA total nominal discharge current per line (based on 8/20µs waveform) for the power input.
5) Have maximum continuous operating voltage (MCOV) rating as required by the associated signal/power circuit(s).
6) Be one of the following:
(a) Edco SLAC series

(b) Dehn Blitzductor XT series (for the analog signal) plus Dehn DEHNguard series (for the power input), combined into (1) overall NEMA 4X enclosure.

2. Networked Instruments:
   a. Provide surge protection device(s) at all power and network connections to the instrument equipment.
   b. At network-powered instrumentation equipment, surge protection device shall:
      1) Be mounted within one (1) appropriately-sized NEMA 4X enclosure with viewing window at the field device.
      2) Be of DIN-rail mountable construction.
      3) Have 1kA total nominal discharge current per line (based on 8/20µs waveform).
      4) Be designed specifically for the associated network connection type (Ethernet, RS485, RS232, etc.).
      5) Be MTL Zonebarrier series or equal.
   c. At separately-powered instrumentation equipment, surge protection device(s) shall:
      1) Be mounted within one (1) appropriately-NEMA 4X enclosure with viewing window at the field device.
      2) Be of DIN-rail mountable construction.
      3) Have 1kA total nominal discharge current per line (based on 8/20µs waveform) for the network signal.
      4) Have 15kA total nominal discharge current per line (based on 8/20µs waveform) for the power input.
      5) Be designed specifically for the associated network connection type (Ethernet, RS485, RS232, etc.) and shall have maximum continuous operating voltage (MCOV) rating as required by the associated power circuit(s).
      6) Be MTL Zonebarrier series or equal (for the network connection) plus Dehn DEHNguard series or equal (for the power input).

C. Installation and grounding of suppressor: As directed by manufacturer. Provide coordination and inspection of grounding.

PART 3 - EXECUTION

3.1. INTERFACE REQUIREMENTS

A. The instrumentation supplier shall forward submittals clearly identifying all instrumentation interface requirements (inputs/outputs, network connections, register locations for network connections, loop power source requirements, etc.) to the supplier of the associated control and monitoring system, or SCADA system, prior to construction of the associated control and monitoring panels, PLC’s, RIO’s, RTU’s, etc.

3.2. IDENTIFICATION AND LABELING:

A. Refer to Specification Section 26 05 53 for identification and labeling requirements.

3.3. INSTALLATION

A. All equipment shall be installed in accordance with the manufacturer’s

recommendations.

B. All mounting hardware shall be of corrosion resistant material unless noted otherwise. In exterior or typical process areas, mounting hardware shall be type 316 stainless steel. In extremely corrosive areas (Chlorine rooms, Fluoride rooms, etc.), mounting hardware shall be of non-metallic construction as recommended by the equipment supplier.

3.4. CALIBRATION

A. All instruments provided, relocated or modified within the project shall be calibrated and ranged by a factory-trained representative to the range specified by the process engineer.
B. All calibration procedures shall be implemented using equipment meeting NIST standards.
C. Calibration sheets shall be used to record all applicable calibration settings and calibration equipment data, and to indicate certification of traceability to National Institute of Standards and Technology (NIST) standards.

3.5. TESTING

A. General
    1. All elements of the instrumentation system shall be tested to demonstrate that the total system satisfies all of the requirements of this specification.
    2. As a minimum the testing shall include the following:
        a. Operational Readiness Test (ORT)
        b. Functional Acceptance Test (FAT)
    3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsection's producing the correct result (effect), the specific test requirement will have been satisfied.

B. Operational Readiness Test (ORT)
    1. General: Prior to start-up, the entire installed instrumentation system shall be certified (inspected, tested and documented) that it is ready for operation.

C. Functional Acceptance Test (FAT)
    1. The entire instrumentation system shall be tested on-site to demonstrate that it is operational and in conformance with these specifications.
    2. Tests shall demonstrate specified functions, calibration and ranging to the satisfaction of the owner.

3.6. TRAINING

A. General
    1. Provide an integrated training program for the owner's personnel at the jobsite. Tailor the training program to meet the specific needs of the Owner's personnel. Include training sessions, classroom and field, for managers, engineers, operators and maintenance personnel.
    2. The training shall be carried out by technically competent and experienced instructors
    3. The Owner shall have the right to make and reuse video tapes of all of the onsite training sessions.

4. A minimum of one eight (8) hour day shall be provided on site for training owner and or engineer selected attendees.

3.7. SPARES:

A. A quantity of spare surge protection devices for field instruments equal to 25% of the quantity specified of each type, or one of each type (whichever is greater) shall be provided. For example, a system with surge protection devices for two (2) loop-powered 2-wire field instruments and nine (9) 120V-powered 4-wire field instruments shall be provided with one (1) spare surge protection device for loop-powered 2-wire field instruments and three (3) spare surge protection devices for 120V-powered 4-wire field instruments.

3.8. SYSTEM DOCUMENTATION:

A. Upon completion of the installation, the instrumentation supplier shall provide full documentation sets (quantity as required by other specification sections) to the owner for approval. Documentation shall include:
   1. A record set of all information submitted prior to installation.
   2. Records of all calibration sheets described above.

3.9. FINAL ACCEPTANCE & SYSTEM CERTIFICATION:

A. Completion of the installation, in-progress and final inspections, receipt of the system documentation, and successful performance of the instrumentation system for a two week period will constitute acceptance of the system.

3.10. WARRANTY/SERVICE AGREEMENTS:

A. The instrument supplier shall provide the following services as a part of this contract:
   1. One year of warranty/service agreements for all instruments, to include start up, all parts, labor, and travel for on-site repairs, 1 on-site calibration per year, factory recommended maintenance (including required parts), unlimited technical support calls, and free firmware updates.

B. The contractor shall additionally fully warrant the completed instrumentation system to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of final acceptance.

END OF SECTION 27 60 05

SECTION 31 10 00 - SITE CLEARING

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. This Section includes the following:

1. Erosion control best management practices (BMP's).
2. Protecting existing trees and vegetation designated to remain.
3. Clearing and grubbing.
4. Topsoil stripping.
5. Demolition of existing above-grade and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place.
7. Demolition of existing site utilities.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIALS OWNERSHIP

A. Anything of value found during the progress of the work, as determined by the Owner, shall become the property of the Owner.

B. All large diameter (12- inch and larger) ductile iron pipe shall be removed and stockpiled for use by the Owner. The Contractor shall remove this pipe in a manner that will allow it to be reused by the Owner.

C. Except for anything of value, materials indicated to be stockpiled or materials indicated to remain the Owner's property, cleared materials shall become the Contractor's property, be removed from the site and legally disposed of by the Contractor.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

1. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

a. Use sufficiently detailed photographs or videotape.
b. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction over the site.

B. Limit of Construction Activity: Unless specifically authorized by the Owner, the Contractor shall confine all construction activity within the boundary of the Project property, adjacent public rights-of-way and prescribed rights-of-way or easements. Work within public rights-of-way is subject to permit. If clearing and grubbing limits are indicated, the Contractor shall confine all construction activity within those limits.

C. Improvements on Adjoining Property: Authority for performing any indicated work on property adjoining the Owner's property shall be obtained by the Owner before award of the Contract.

D. Items to be Salvaged: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

E. The Contractor shall utilize utility locator services for the Project site before any site clearing work is commenced.

PART 2 - PRODUCTS

2.1 EROSION CONTROL MATERIALS

A. Silt Fence Materials: Silt fences shall consist of a geotextile filter fabric attached to posts by means of adjustable belts or loops or other means that will securely hold the fabric in an upright position. The filter fabric shall be a polymeric fabric formed from a plastic yarn of long-chain synthetic polymer composed of at least 85% by weight of propylene ethylene, amide, ester or vinyledene chloride and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure for at least six months. The filter fabric roll shall be a minimum of three feet in width.

1. The filter fabric shall conform to the following physical requirements:

Physical Property	**Test Method**	**Test Results**
Grab Tensile Strength, lbs, min.	ASTM D-4632	120
Grab Elongation, %, max.	ASTM D-4632	40
Mullen Burst Strength, psi, min.	ASTM D-3786	175
Apparent Opening Size, max., U.S. Standard Sieve	ASTM D-4751	30
Flow Rate, max. gal/minute/ft^2	ASTM D-4751	30
UV Resistance, %, min.	ASTM D-4632 ASTM D-4355	70

B. Riprap Materials:

1. Riprap shall be limestone conforming to the requirements of GDOT Specifications Section 805.201, Type 3 Riprap (unless otherwise specifically shown on Drawings).
2. Riprap bedding, where required, shall consist of gravel or crushed stone GDOT Size #467. All stone for riprap and bedding, such as shot rock, quarry rock, quarry waste or other materials, shall be sound, durable, and free from seams, cracks or other structural defects.

C. Grouted-In Riprap Materials: Riprap stone to be grouted in place shall be of the same size and placed in the same manner as specified for riprap. Grout for grouted-in riprap shall consist of 1 part hydraulic cement to 3 parts sand, thoroughly mixed with water to produce a thick, creamy consistency.

D. Geotextile Riprap Bedding Materials: The geotextile shall be of nonwoven construction. The geotextile shall be mildew, insect, and rodent resistant and shall be inert to chemicals commonly found in soil.

1. The geotextile shall conform to the physical property requirements listed in the table below:

Physical Property	Test Method	Test Results
Grab Tensile Strength, lbs, min.	ASTM D-4632	120
Puncture Strength, lbs, min.	ASTM D-4833	70
Grab Elongation, %, max.	ASTM D-4632	50
Mullen Burst Strength, psi, min.	ASTM D-3786	240
Apparent Opening Size, max., U.S. Standard Sieve	ASTM D-4751	70
Flow Rate, max. gal/minute/ft^2	ASTM D-4751	135

2. The geotextile shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling. The fabric shall be ultraviolet stabilized.

E. Hay Bale Materials: Hay bales shall be rectangular and may be either hay or straw securely bound with twine or wire. Bales shall contain a minimum of 5 cubic feet of material and shall weigh a minimum of 35 pounds when dry.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain and to be protected. All work shall be performed within the limits shown.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to the Owner.

3.2 EROSION CONTROL BEST MANAGEMENT PRACTICES (BMP's)

A. General:

1. The Contractor shall utilize erosion control best management practices (BMP's) to prevent the discharge of sediment-bearing water runoff or airborne dust from the project site in accordance with all federal, state and local regulations during construction.
2. The Contractor shall be responsible for obtaining an NPDES Permit for stormwater discharge from the construction site(s) for all work described in these Specifications and shown on the Drawings. It shall be the Contractor's responsibility to meet all requirements and obligations of the Permit. The Contractor shall be responsible for all costs associated with making application for the permit and for meeting the requirements of the Permit.
3. The Contractor shall be responsible for the inspection and maintenance of all BMP's in accordance with the requirements of the permitting authority.
4. The Contractor shall ensure that all downslope BMP's are installed and functional before any land disturbing activity is commenced on any portion of the site.
5. The Contractor shall be responsible for the installation and maintenance of additional BMP's if required by field conditions, the Engineer or a permitting authority having jurisdiction over the site.

B. Silt Fence:

1. The installation of silt fences shall be in conformance with the silt fence manufacturer's recommendations. Particular care shall be exercised to ensure that all silt fencing is properly keyed into the earth at the toe.
2. The Contractor shall maintain, clean, repair or replace silt fence as may be required during the construction period. If a line of silt fencing exceeds its capacity to function properly and the need for a back-up fence becomes evident, the Contractor shall install a secondary line of silt fence at the affected area as required and authorized by the Engineer. Failure to maintain a silt fence shall not be cause for the Contractor to claim additional compensation.

C. Riprap:

1. Placement: Riprap shall be placed in accordance with GDOT Specifications Section 805.201 for Type 3 riprap. Riprap shall be placed in such a manner as to produce a reasonably well graded mass or rock having the minimum practical percentage of voids. Riprap shall be placed to its full course thickness in one operation, and in such a manner as to avoid displacement of bedding material if bedding is required. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. The dumping of riprap shall be allowed provided that riprap bedding material, if required, is not displaced and that mechanical equipment is used to dress the stones to a reasonably uniform slope.
2. Riprap placed in unauthorized locations without prior approval of the Engineer shall be considered to have been wasted, and, therefore, placed at no cost to the Owner.
3. The Contractor shall maintain all riprap protection until the project is accepted, and any material displaced by any cause prior to acceptance of the project shall be replaced at the Contractor's expense.

D. Geotextile Riprap Bedding: The fabric shall be placed in the manner described and in accordance with the manufacturer's recommendations.

1. The surface to receive the geotextile shall be prepared to a smooth condition free of obstructions, depressions and debris.
2. The fabric shall be placed loosely, not in a stretched condition.
3. The riprap shall be carefully placed so that the geotextile is not punctured.
4. The riprap shall completely cover the fabric.
5. The fabric shall be placed on the slopes so as to provide a minimum overlap of 18 inches at seams.
6. The geotextile may be placed with seams either parallel or perpendicular to the direction of the flow. If placed perpendicular to the flow, the upstream or higher panel shall overlap the downstream or lower panel. At the top of the bedding installation the fabric shall be keyed into the ground a minimum of 18 inches.
7. If a cushion layer is required, the bottom toe shall be finished by lapping the fabric back onto the cushion layer and securing with riprap.

E. Hay Bales: Hay bales shall be installed using keyways cut into grade or aggregate fill bedding as required. All hay bales shall be properly oriented and staked. Hay bales shall be removed and properly disposed of when the project area upslope from them has been stabilized.

1. The Contractor is responsible for the periodic checking and maintenance of hay bale installations. Silt trapped by hay bale installations shall be removed and properly disposed of.

F. Rock Check Dams: Rock check dams shall be carefully installed in the drainage ditch. Rock check dams shall be removed and properly disposed of when the project area upslope from them has been stabilized.

1. The Contractor is responsible for the periodic checking and maintenance of rock check dam installations. Silt trapped by rock check dam installations shall be removed and properly disposed of.

G. Sediment Traps: Sediment traps shall be backfilled and any associated granular material removed and properly disposed of when the project area upslope from them has been stabilized.

1. The Contractor is responsible for the periodic checking and maintenance of sediment trap installations. Silt trapped by sediment trap installations shall be removed and properly disposed of.

H. Temporary Sediment Basins: Temporary sediment basins which are installed at locations other than permanent storm water detention basins shall be backfilled and any associated granular material removed and properly disposed of when the project area contributing runoff to them has been stabilized.

1. Permanent storm water detention basins with temporary modifications to their outlet structures may serve as temporary sediment basins. The Contractor shall remove the temporary outlet structure modifications and properly dispose of the associated materials when the project area contributing runoff to the permanent storm water detention basin has been stabilized.
2. The Contractor is responsible for the periodic checking and maintenance of temporary sediment basin installations. Silt trapped by temporary sediment basin installations shall be removed and properly disposed of.

I. After stabilization of the disturbed area has been achieved, the Contractor shall remove and dispose of all temporary BMP's and dress out those areas to the proper line and grade.

3.3 PROTECTION OF DESIGNATED VEGETATION OR INDIVIDUAL TREES

A. The Contractor shall erect and maintain a clearly marked temporary fence around designated areas of the site, the perimeter drip line of groups of trees or the drip line of individual trees designated to remain and be protected.

1. Do not store construction materials, debris, or excavated material within the above-described fenced areas.
2. Do not permit vehicles, equipment, or foot traffic within the above-described fenced areas.
3. Remove temporary fencing around the above-described areas upon substantial completion.

B. Where excavation for new construction is required within areas designated to remain and be protected, the Contractor shall hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to the excavation limits as possible.

1. Cover exposed roots with burlap and water regularly.
2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
3. Clean cut limbs which obstruct the work. Minimize limb cutting as much as practicable.
4. Coat cut faces of roots or limbs more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
5. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

C. Repair or replace trees and vegetation indicated to remain and be protected that are accidentally damaged by construction operations.
1. Replace trees that cannot be repaired and restored to full-growth status, as determined by the Engineer.

3.4 UTILITIES

A. The Contractor will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing.

1. Contractor shall coordinate with utility companies to shut off indicated utilities.
2. Contractor shall arrange for utility company to locate, identify, disconnect, and seal or cap off utilities indicated to be removed, or shall receive written permission from utility companies to perform work.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify utility companies in accordance with their policies in advance of any proposed utility interruption.
2. Do not proceed with utility interruptions without written permission from the Engineer.

3.5 CLEARING AND GRUBBING

A. Clearing and grubbing shall consist of cutting, removing and disposal of all trees, tree stumps, brush, grass, roots and other organic material within areas to be subject to earthwork and/or occupied by proposed structures or facilities. If clearing and grubbing limits are indicated, those lines shall define the extent of clearing and grubbing activity on the site.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated. Contractor shall replace all damaged tees, shrubs, or other vegetation at no cost to the Owner.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
4. Roots projecting from the walls of excavations shall be either cut or removed to provide a minimum clearance of 3 feet for the outside line of structures.

B. Fill depressions caused by clearing and grubbing operations with fill material in accordance with Division 2 Section “Earthwork” unless area is designated for further excavation.

3.6 TOPSOIL STRIPPING

A. Strip topsoil to the depths indicated in the geotechnical report or a minimum depth of 6 inches.

1. The stripping layer may include topsoil, muck, trash, debris, grass, weeds, roots and other organic materials.
2. The stripping process should result in a clean subgrade surface free from organic material and ready for earthwork operations.

B. Stockpile topsoil materials in areas which will prevent intermixing with subgrade or fill soils. If topsoil is stockpiled on site, the stockpile locations must be acceptable to the Engineer and the Owner. Stockpile locations shall allow for access for the re-loading and spreading of topsoil.

1. Grade and shape stockpiles to drain surface water.
2. Stockpiles shall be protected from wind erosion by periodic water sprinkling, covering or temporary seeding.
3. Dispose of excess topsoil as specified for waste material disposal.

3.7 DEMOLITION OF EXISTING SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate construction. Break holes in structures as required to prevent collection of groundwater.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

C. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.8 DISPOSAL

A. Disposal: The Contractor shall remove cleared vegetation, surplus soil material, surplus topsoil, demolition debris, and waste materials including trash and dispose of them off of the Owner's property. All disposal shall conform to all applicable federal, state and local regulations.

END OF SECTION 31 10 00

SECTION 31 20 00 – EARTH MOVING

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. This Section includes excavation and backfill for structures, pipelines, embankments and other areas.

B. If the Owner has engaged a geotechnical engineer to investigate the subsurface conditions, then the Owner may share this information with the Contractor. However, the Contractor shall only rely on this information at their own risk, and the Contractor shall make whatever additional investigations they believe to be necessary for bidding and construction purposes. If the Contractor desires to make their own investigations prior to bidding the project, then the Contractor shall coordinate this work with the Owner. The Owner/Engineer is not responsible for variations in subsurface conditions (soil, rock, groundwater, etc).

1.3 DEFINITIONS

A. Backfill: Suitable soil materials used to fill an excavation.

B. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

C. Base Course: Layer placed between the subgrade and slabs-on-grade, walkways, and pavements.

D. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

E. Borrow: Suitable soil imported from off-site for use as fill or backfill.

F. Crushed Stone Backfill: Crushed stone, where specified to be used as backfill or a stone cushion for structures shall be crushed stone meeting Georgia Department of Transportation Gradation #57.

G. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.

H. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Excavation: Removal of material encountered above subgrade elevations.

1. Earth Excavation: Removal of all materials, not including that specified under the "Clearing and Grubbing" and "Rock Excavation" items. Rocks and boulders eight (8) cubic feet or less in volume shall be classified as earth.
2. Rock Excavation: loosening, removing, and disposing of all rock in original bed, in well defined ledges, or in boulder form. Boulders having a volume of eight (8) cubic feet or less shall not be classified as rock. Material that can be loosened, separated, or ripped by means of heavy duty power tools or excavating equipment shall not be classified as rock.
3. Additional Excavation: Excavation below subgrade elevations as directed by Engineer.
4. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

J. Fill: Suitable soil materials used to raise existing grades.

K. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

L. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

M. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

N. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.

O. Suitable Soils: As defined in the geotechnical report (if applicable), or the following ASTM D 2487 soil classification groups as a minimum; GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

P. Unsuitable Soils: As defined in the geotechnical report (if applicable), or the following soil classification groups as a minimum; ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols. Unsuitable soils also include suitable soils not maintained within 2 percent of optimum moisture content at time of compaction.

Q. Utilities include on-site underground pipes, conduits, ducts, and cables.

1.4 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by the Owner and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.

3. Contact utility-locator service for area where Project is located before excavating.
4. All existing underground utilities may not be indicated. Contractor is responsible for locating all underground utilities before beginning excavation.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient suitable soil materials are not available from excavations.

B. Structural Backfill:

1. Suitable backfill materials shall be within moisture limits required for compaction; silty-clay, weathered shale or other suitable soil mixtures; and such soils shall not contain rock or stone in sizes greater than ½".
2. Native soils as excavated from the site may be used provided that they satisfy the criteria specified herein. If native soils are unsuitable, then Contractor shall furnish and install suitable soils from off-site at Contractor's expense.
3. Material for structural and general backfill may be that excavated on the site; but in the event that the excavated material is not in suitable condition at the time when it is required for backfilling purposes, or the quantity of material excavated is not sufficient to make the finished fills indicated, the Contractor shall provide, at his own expense, such additional suitable material as is required.
4. If paved areas (or areas to be paved) abut structures, then backfill material under these areas shall be crushed stone.
5. Contractor is responsible for removing and disposing of unsuitable materials off-site, unless otherwise specifically shown to be disposed of on-site.

C. Utility Trench Bedding and Backfill:

1. Bedding Materials

a. Where trenches are excavated in soil, bedding material shall be #57 stone to a depth of approximately 4" under barrel of pipe.
b. Where trenches are excavated in rock, bedding material shall be #57 stone, placed and compacted to a depth of approximately 6" under barrel of pipe.

2. Backfill Materials

a. Where trenches are excavated in soil, backfill material shall be #57 stone to ½ the depth of the pipe, then the remainder shall be suitable soil placed and compacted as described in these Specifications.
b. #57 stone shall be used in the following locations:

1) For backfill where trenches are excavated in rock (to a depth of 12 inches above the top of the pipe)

2) For backfill in trenches cut in paved streets, in paved areas, areas to be paved as part of this Contract or future work, beneath footings, beneath slabs, or as specifically indicated.
3) For backfill (to a depth of 12" above the highest pipe) in areas of general excavation (where pipe lines are installed and where, because of proximity of several pipe lines, individual trenches cannot be excavated), and in areas where two or more utilities cross.

c. The top foot of depth of all trenches (except under slabs, footings, roads, walks and paved areas, along road shoulders and other areas where crushed stone may be specified or directed to be used) shall be backfilled with soil that can be smoothly dressed to match surface of ground adjoining the edges of the trench, and that will support the vegetation desired for the finished surface and required by the finished grading and grassing requirements.

D. Embankment and Fill Work:

1. The material used in embankments and fills shall be free from frost, stumps, trees, roots, sod, muck or debris of any kind.
2. Only materials as specified herein and/or approved by the geotechnical engineer shall be used.
3. Fill and embankment materials shall not be placed on frozen ground.
4. Embankment and fill materials shall be provided as follows:

a. Underneath grass and planted areas: Use suitable soils.
b. Underneath walks and pavements: Use suitable soils.
c. Underneath footings, foundations, building slabs, steps and ramps: Use suitable soils, crushed stone, or #57 stone or as indicated in the geotechnical report.
d. Dikes and/or Embankments Intended to Hold Water: Use an impervious fill such as a sandy-clay or clayey sand or as indicated in the geotechnical report.

5. Rock greater than two (2) inches in any dimension shall not be placed in compacted fills for embankments, dikes or earth sections forming the walls of water containing structures (holding ponds, reservoirs, lagoons, etc.) unless all voids are filled with fine material and the complete fill is compacted to a dense mass as specified hereinabove.
6. Rock greater than one (1) cubic foot in volume, or having any dimension greater than one (1) foot, shall not be placed in compacted fills in areas to be occupied by structures, bearing slabs, footings, roadways, walks, etc.

a. Rock of permissible size deposited in such fills shall be placed in layers not greater than one (1) foot in depth, and such rock layers shall be separated by not less than one (1) foot (compacted thickness) of clay or other acceptable backfill material.
b. Rock shall not be placed nearer than two (2) feet to the surface of any fill, nor nearer than three (3) feet to the wall or surface of any structures.

7. Rock shall not be placed in fill areas which pipes, conduits, cables, etc., are to be laid, nor shall rock be placed in trench backfill except as described in these Specifications.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways in accordance with Division 2 Section “Site Clearing.”

3.2 SITE DRAINAGE

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.
3. The Contractor shall complete all dewatering operations and dispose of the water from the work in a manner that will not cause damage to adjacent properties or environment, nor restrict access to any new or existing facilities. No water shall be drained into work under construction.
4. The Contractor shall keep excavations and work dry until the structures or facilities to be constructed are completed and the Engineer is in agreement with the Contractor to discontinue dewatering operations.

C. Drainage Ditches:

1. New ditches shall be cut and existing ditches shall be cleaned out and extended as required to provide for surface drainage around structures and to divert water away from excavations.
2. New (permanent) ditches:

    a. Flowlines shall be graded as indicated.
    b. The cross-sections of the ditches shall conform to details specified.

3. Temporary ditches:

a. When temporary ditches have served their purpose, all such ditches shall be filled and finished to conform to existing contours or finished contours.
b. It shall be the Contractor's responsibility to provide and maintain drainage ditches during the progress of the work.

3.3 EXPLOSIVES

A. Blasting will not be allowed.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. All excavation for this Project is unclassified.
2. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. General Rock Excavation:

1. All rock excavated from the site shall be designated as rock spoil. Rock spoil must be removed and disposed of off-site unless Contractor receives written permission from Engineer to use it for rip rap on-site, or to dispose of it on-site in non-structural fill areas.
2. The permission of the Owner shall be secured before any rock spoil is disposed of on site.

C. The Contractor is reminded that all excavation is under the protective guidelines and requirements of OSHA "Safety and Health Regulation for Construction", as set forth in the Federal Register, latest revision, and all such protections are the responsibility of the Contractor and shall be provided at the Contractor's expense.

3.5 SHEETING, SHORING, AND BRACING

A. Sheeting, shoring, bracing and sloping are methods of excavation, and such methods may vary according to the Contractor's methods of dewatering, excavating and installing the work.

B. All such methods of accomplishing the work are the sole responsibility of the Contractor, in accordance with the OSHA guidelines referred to hereinabove, and the sole responsibility of the Engineer is to review the finished work for compliance with the requirements of the Plans and Specifications.

3.6 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Earth Excavation for Footings, Foundations, and Floor slabs: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete

reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

a. In the event that, at the elevation indicated, soil over the general area to be occupied by a bearing slab is found to be unsuitable for supporting the design load, the Contractor shall remove such soil and replace it with backfill material (compacted as specified herein), crushed stone, or concrete as concurred with the Engineer.
b. In the event that, at the elevation indicated, soil over the area to be occupied by footings is found to be unsuitable for supporting the design load, the Contractor shall remove such soil and replace it with backfill material (compacted as specified herein), crushed stone, or concrete as concurred with the Engineer.
c. Excavations shall not be exposed to rainfall and must be protected to keep dry. Excavations that are exposed to excessive moisture must be re-worked or soil must be replaced at Contractor's expense.

2. Rock Excavation for footings, foundations, and floor slabs: Where rock is found to be the supporting material for footings, foundations, or floor slab, the Contractor shall reasonably clean the foundation area in order that proper inspection and evaluation of foundation conditions can be made.

a. If unusual conditions such as would be indicated by presence of seams, fissures or voids should be found, the Contractor may be directed to perform additional cleaning work, utilizing air jets, water jets, or other suitable methods.
b. All seams, voids or fissures found shall be filled with crushed stone of gradation suitable for the particular situation encountered.
c. In the event that, when excavation to grade line has been completed, it is found that the footing, foundation or slab would bear partly on soil and partly on rock, the rock shall be excavated to depth of six inches (6") below the gradeline indicated and/or specified herein, and a compacted crushed stone cushion shall be placed on the rock surface before the concrete is poured. The compacted cushion shall be wetted before placement of concrete.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. All trenches for pipe shall be excavated in open cut to such depths as indicated or as required to secure the specified minimum cover over the pipe.

B. Where trenches are excavated in native soil, excavation shall be carried to a depth of approximately 4" under barrel of pipe for placement of the specified bedding material.

C. The trench shall have a uniform cross section and bottom conforming to the grades as indicated.

D. The pipe shall be laid on firmly compacted approved bedding material, and the barrel of the pipe shall have uniform bearing for its full length.

E. Any part of the trench excavation below the grade specified shall be corrected with bedding material placed and compacted in accordance with the requirements of these Specifications.

F. Where unsuitable or unstable material is encountered at the elevation indicated, the Contractor shall excavate below the grade (or elevation) shown and backfill such excavation with bedding or stabilizing material.

G. Boulders and large stones, rock or shale, shall be removed to provide a clearance of at least six (6) inches below all parts of the pipe or fittings and to clear width of at least six (6) inches on each side of all pipe and appurtenances.

H. Where the trench is excavated in rock or shale, the six (6) inch space below the pipe shall be filled with crushed stone firmly compacted in accordance with these Specifications to form a cushion for the pipe.

I. Bell holes of ample dimensions shall be dug to permit joining to be properly made and to insure that the pipe is evenly supported throughout its length rather than on joints or couplings.

3.8 SUBGRADE

A. Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer.

3.9 UNAUTHORIZED EXCAVATION

A. In the event that the Contractor should excavate below the grade specified, and excess excavation is not authorized by the Engineer, such excess excavation shall be backfilled to the grade specified and/or indicated with compacted crushed stone or compacted backfill material. All such backfilling of excess excavation shall be done at the Contractor's expense.

B. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

2. Stockpile soil materials in a manner that will not cause damage to adjacent properties or environment, nor obstruct access to any new or existing facilities.
3. Drainage lines shall not be obstructed nor shall natural drainage of the surrounding ground be altered or obstructed.
4. If Contractor mixes suitable and unsuitable soil materials, then Contractor shall furnish and install equivalent amount of suitable materials from off-site at no additional cost to the Owner.

3.11 BACKFILL, EMBANKMENTS, AND FILL WORK

A. General: Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Embankments and fills shall not be started without the concurrence of the Engineer.
8. If embankment or fill is to be placed on a surface which slopes more than 4:1, the surface shall be scarified and compacted to provide bond with the new material.
9. Steep slopes may require the existing surface to be benched.
10. Wet ground to be covered by fill shall be drained.

B. Compaction Requirements:

1. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
2. Under structures, building slabs, steps, and pavements, scarify and recompact top 6 inches of existing subgrade and each layer of backfill or fill material at 98 percent.
3. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 95 percent.
4. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 90 percent.
5. Place base course material over subgrade.
6. Compact base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 1557.
7. Shape base to required crown elevations and cross-slope grades.
8. When thickness of compacted base course is 6 inches or less, place materials in a single layer.
9. When thickness of compacted base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

C. Drainage Courses: Under slabs-on-grade, place drainage course on prepared subgrade and as follows:

1. Compact drainage course to required cross sections and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698.
2. When compacted thickness of drainage course is 6 inches or less, place materials in a single layer.
3. When compacted thickness of drainage course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

3.12 STRUCTURAL BACKFILL

A. General:

1. Backfill shall be made around the walls of the structures as indicated; and backfill shall be placed only after the walls have gained sufficient strength to support the load.
2. No rock shall be placed in fill within three (3) feet of the walls of structures.
3. In all fill work the best dirt shall be used as top soil for any planting, sprigging, or sodding that may be required.
4. Backfill material shall be placed within foundation walls, under footings or slabs, under and around piping installed under footing or slabs, under and around piping located in areas of general excavation (where because of proximity of several pipe lines individual trenches could not be excavated) as indicated.
5. All such backfill material for purposes specified hereinabove, whether obtained from suitable on-site soils, crushed stone, or from suitable off-site soils, shall be furnished and placed by the Contractor at the Contractor's expense.
6. The Contractor shall be responsible for maintenance of the backfill; and shall promptly re-work and/or refill any areas where settlement of backfill has occurred.
7. All backfill around structures shall be sloped and graded as indicated or as requested by the Engineer.
8. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
9. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
10. The surface of each layer shall be kept parallel to the elevation of the finished compacted fill by use of blade graders. In proximity to existing structures, leveling shall be accomplished by use of small spreaders, bulldozers, or hand method.
11. Each layer shall be compacted by use of heavy earth compaction equipment suitable for the particular type of soil/stone.
12. Each layer shall be rolled and compacted to the specified density before the succeeding layer is placed.
13. The final layer shall be brought to elevation of finished compacted fill before topsoil or pavement is placed to conform to the finished contour specified.

3.13 UTILITY TRENCH BACKFILL

A. General:

1. The Contractor shall notify the Engineer prior to backfilling any trench in which pipe has been installed.
2. No extra compensation will be allowed for backfill as specified herein.

3. Trench backfill materials shall be thoroughly compacted by means of pneumatic tampers or mechanical tampers.
4. Each layer of trench backfill shall be carried up to the same level on both sides of the pipe so as to avoid unbalanced loading.
5. Each layer of trench backfill shall be evenly compacted on both sides of pipe before the next layer is placed.
6. Backfill for pipe line trenches shall be placed in 4" layers from the bottom of the trench to a level 12" above the top of the pipe.
7. Backfill above a level 12" above the crown of the pipe shall be placed in layers not exceeding 6" in areas beneath pavement, slabs, footings, etc. and 12" in thickness elsewhere.
8. After the pipe has been covered to elevation three (3) feet above top of pipe, backfilling may be accomplished by use of bulldozer, bucket or other mechanical equipment if carefully performed in a manner suitable to the Engineer.
9. #57 stone backfill shall extend out from either end (or side) of the paved areas, slab or footing and along the trench on a 1:1 slope.

B. Special Trench Conditions: Where the character of the soil is such that the employment of proper and adequate drainage of the work will not enable the Contractor to secure a suitable bed for the pipe, the Engineer may request the Contractor to excavate below the specified bedding depth, and backfill the excess excavation with #57 stone. Backfill throughout remainder of trench depth shall be as specified.

3.14 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Provide a smooth transition between adjacent existing grades and new grades. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

C. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will select a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

1. The cost of initial sampling and testing shall be bourne by the Owner.
2. Subsequent re-testing of any samples or locations failing the initial test shall be performed at the expense of the Contractor.

B. Allow testing agency to inspect and test subgrades and to test each lift of fill or backfill as frequently as recommended by the geotechnical engineer, or as recommended by Engineer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements. Contractor shall be responsible for scheduling testing at the required intervals as work progresses.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: The Contractor shall remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off of Owner's property.

B. The Contractor shall make all necessary arrangements for disposal areas, and pay all costs incidental to securing permission for their use and shall dispose of all surplus material without cost to the Owner, other than as reflected in the prices bid.

END OF SECTION 31 20 00

SECTION 31 23 19 - DEWATERING

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 construction dewatering.

B. Groundwater conditions are likely to fluctuate. The Contractor is solely responsible for all dewatering, including groundwater, leaks from process structures, piping, and/or other sources. The Contractor is also solely responsible for making provisions to prevent flotation of structures, piping, equipment and appurtenances during construction. The Contractor shall make whatever investigations they deem necessary (before bidding and during construction) to quantify groundwater and to develop sufficient plans for dewatering.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written plan for dewatering operations including control procedures to be adopted if dewatering problems arise.

B. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in dewatering work.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is included in the Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps,

sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 31 23 19

SECTION 32 12 16 - HOT MIX ASPHALT PAVING

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. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving overlay.
4. Asphalt surface treatments.
5. Pavement-marking paint.
6. Cold milling of existing hot-mix asphalt pavement.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to the standard specification for definitions of terms.

B. DOT: Department of Transportation.

C. GDOT: Georgia Department of Transportation.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of the standard specifications of the state DOT.

1. Standard Specification: Standard Specifications Construction of Transportation Systems, Georgia Department of Transportation, 2021 Edition.

2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

A. **Certification from Contractor and Manufacturer/Suppliers:** During the bid period and again prior to submitting/ordering and installing materials, products and equipment, the Contractor and all manufacturers and suppliers shall thoroughly review the materials, products and equipment being supplied and shall familiarize themselves with the existing and proposed/new facilities, as well as connections to existing

facilities/utilities. This shall include field verification of the location, nature, size/dimensions, current and intended future use, etc. Prior to ordering and installation, the Contractor shall coordinate with all manufacturers and suppliers to provide all needed information including field dimensions, photographs, information on related materials and equipment, etc.). The Contractor and all manufacturers and suppliers shall include written confirmation (with the submittal) of the following:

1. The materials, products, and equipment being supplied are of the correct size, materials and type.
2. The materials, products and equipment being supplied do not conflict with existing or proposed/new facilities.
3. The products/equipment being supplied are intended for use in this application.
4. All manufacturer(s) and supplier(s) shall provide (either with submittals or separately) written concurrence/acknowledgement of their review/coordination and concurrence with the items above.
5. Shop drawings and product data submitted for review by the Engineer shall bear the Contractor's certification that he has reviewed, checked, and approved the submittals, that they comply with the requirements of the project and with the provisions of the Contract Documents, and that he has verified all sizes, dimensions, locations, field measurements, construction criteria, materials, catalog numbers, and similar data. Field dimensions, sizes and other pertinent information shall be clearly shown on the shop drawings/submittals. The Contractor shall also certify that the work represented by the shop drawings is recommended by the Contractor and that the Contractor's warranty and guaranty will fully apply.

B. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

C. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Regulatory Requirements: Comply with Georgia Department of Transportation for asphalt paving work, delivery, storage, and handling.

C. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

D. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or frozen or if the following conditions are not met:

1. Prime and Tack Coats: Minimum surface temperature of 40 deg F.
2. Asphalt Binder Course: Minimum surface temperature of 45 deg F and rising at time of placement.
3. Asphalt Wearing Course: Minimum surface temperature of 55 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Graded Aggregate Base: Conforming to GDOT Standard Specifications for graded aggregate base materials.

2.2 ASPHALT MATERIALS

A. Binder Course: Conforming to GDOT Specifications, 19 MMSP Binder

B. Wearing Surface Course: Conforming to GDOT Specifications, 9.5 MM Topping

C. Tack Coat: Conforming to GDOT Specifications

2.3 AUXILIARY MATERIALS

A. Pavement-Marking Paint: Class 1 (Paint), Type B (non-reflectorized) designating paint conforming to GDOT Specifications

B. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subgrade using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Notify Engineer in writing of any unsatisfactory subgrade conditions.

D. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PLANING (MILLING)

A. Plane existing pavement surface in accordance with GDOT Specification. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Repair or replace curbs, manholes, and other construction damaged during cold milling.
2. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
3. Transport milled hot-mix asphalt to asphalt recycling facility or lawful disposal facility.

3.3 PAVEMENT REPLACEMENT

A. Replaced pavement:

1. Shall be of the same type and thickness as the original pavement
2. However, the replaced pavement shall be at least equal to that specified herein.

B. Materials for base course under pavement shall be:

1. Crushed stone meeting the requirements of Georgia Department of Transportation Specifications.
2. Premixed in accordance with the requirements of Georgia Department of Transportation Specifications and shall conform to the following requirements:

a. Material shall be uniform in color and gradation
b. Material shall have moisture content suitable for attainment of the desired compacted density.

C. Base course for replaced pavement shall conform to the following requirements:

1. Thickness:

a. Not less than that of the original pavement,
b. Or a minimum acceptable compacted thickness of not less than 6".
c. If the thickness of the existing pavement base should be greater than 6", the new base material shall be placed in layers not exceeding 6" in thickness.

2. Each layer of base material shall be compacted to approximately 98% of Standard Proctor Density.
3. Protection and maintenance of base layers prior to the placement of bituminous pavement shall be the responsibility of the Contractor.

D. Where the original pavement was of the bituminous plant mixed type:

1. The Contractor shall replace the original pavement with hot bituminous plant mix meeting the requirements of Georgia Department of Transportation Specifications Section 400.
2. Construction of the replaced pavement shall conform to the requirements of Georgia Department of Transportation Specifications Section 400.

3. Thickness of layer of plant mix shall be equal to that of the original pavement, but shall not be less than 1" (±-1/4") in thickness.

E. Where the original pavement was of the bituminous surface treatment type:

1. The Contractor shall replace the original pavement with double surface treatment type conforming to the requirements of Georgia Department of Transportation Specifications.

F. Where the original pavement was bituminous surface treatment type:

1. The Contractor, at his or her option, may elect to replace the surface treatment type with plant mix type as specified hereinabove.
2. In such case, thickness of replaced pavement shall be approximately 1" (approximately 105#/SY).

G. Replacement of bituminous surface course in the City of right-of-ways or Highways shall conform to the following requirements:

1. The Contractor shall pour an eight (8") inch concrete slab in accordance with details shown on the Drawings.
2. Backfill under this eight (8") concrete slab shall be crushed stone as described in BACKFILL FOR TRENCHES.
3. Concrete shall be Class "A" concrete, as defined in these Specifications.
4. If the pavement is to be opened to traffic in less than 14 days:

    a. High-Early Strength Portland Cement shall be used in the concrete mixture.
    b. If Type I Portland Cement is used, the cement factor shall be increased to 7 bags per cubic yard and the quantity of water set to give slump of 2" or less.

5. Where bituminous pavement is cut in private drives or areas outside of public Right-of-Ways, the eight (8") inch slab may be omitted if approval of the Public Authority having jurisdiction over such matters is obtained in writing.

    a. If the concrete slab is omitted, the Contractor shall replace bituminous surface courses in accordance with these Specifications.

6. Upon placement of the concrete slab, and after allowance of sufficient time for curing:

    a. The surface of the concrete slab be primed in accordance with GDOT Specifications.
    b. A tack coat shall be thoroughly applied to the edge of the existing pavement at the sides of the patch by utilizing the same material used for prime coat on the concrete slab.

H. Should the Contractor delay or postpone the final paving over the trenches, he shall provide a temporary wearing surface for service until such time as the final paving replacement is performed.

1. Temporary paving shall conform to the following requirements:

a. Paving shall be bituminous surface treatment type, single or double, or layer of bituminous mix, according to the Contractor's judgment as to the time interval between temporary and final paving.
b. It shall be the Contractor's responsibility to maintain the temporary paving in such condition as to prevent hindrance or hazard to traffic.
c. When final paving is undertaken:

1) The temporary surfacing materials shall be removed to accommodate final paving of types and thicknesses as specified hereinabove.
2) The edges of the existing paving shall be neatly and uniformly trimmed
3) The permanent pavement shall be placed.
4) No extra compensation will be allowed for provision and maintenance of temporary paving.

I. Where the pipelines traverse or cross streets, highways, roads or driveways:

1. The Contractor shall conduct his construction operations in such a manner as to minimize interference with traffic and public convenience.
2. All travel ways (highways, roads, streets, driveways, etc.) adjacent to or in the vicinity of the construction work shall be kept free from soil or mud resulting from wash or other movement of stored excavated materials or from transport of materials associated with the construction work.
3. It shall be the responsibility of the Contractor to employ such measures as would reasonably prevent the development of traffic hazards and/or air pollution resulting from his construction operations, such as:

a. Cleaning and washdown of paved surfaces.
b. Sprinkling of unpaved streets affected by his construction operations.

J. Paving replacement on Public Rights-of-Way:

1. Shall meet the requirements of the Public Authority having jurisdiction
2. Shall be subject to inspection and acceptance by the Public Authority having jurisdiction.

3.4 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.03 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

D. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Tack Coat: Apply uniformly to surfaces of existing pavement or binder course in accordance GDOT Standard Specification.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 PAVING GEOTEXTILE INSTALLATION

A. Paving geotextiles shall be placed shall be placed in accordance with GDOT Standard Specification.

3.7 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface in accordance with GDOT Standard Specifications. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted. Maximum allowable aggregate size for each pavement layer shall not exceed (0.4 x Thickness of pavement layer).

3.8 JOINTS

A. Construct joints in accordance with GDOT Standard Specifications. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 180 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 94 percent of reference laboratory density according to AASHTO T 209, but not less than 92 percent nor greater than 96 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 1559 (Marshall Method), but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Binder Course: Plus or minus 1/4 inch.
2. Wearing Course: Plus or minus 1/4 inch.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 16-foot straightedge applied transversely or longitudinally to paved areas:

1. Wearing Course: 1/4 inch (6 mm).

3.11 SURFACE TREATMENTS

A. Slurry Seals: Apply slurry coat in accordance with GDOT Standard Specifications.

3.12 PAVEMENT MARKING

A. Apply pavement-marking paint using layout, colors, and placement indicated.

B. Allow paving to cure before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply, in two coats, at manufacturer's recommended rates.

3.13 WHEEL STOPS

A. Securely attach wheel stops into pavement as indicated. Recess head of dowel beneath top of wheel stop.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to [ASTM D 979] [or] [AASHTO T 168].

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188, ASTM D 1559 or ASTM D 2726.

a. One core sample will be taken for every 500 sq. yd. (418 sq. m) or less of installed pavement, with no fewer than 3 cores taken.

b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188, ASTM D 1559 or ASTM D 2726.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.15 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

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. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer of detectable warnings, ready-mix concrete manufacturer, and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

E. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials 55 deg F (12.8 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from galvanized-steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

C. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.

H. Plain-Steel Wire: ASTM A 82/A 82M

I. Deformed-Steel Wire: ASTM A 496/A 496M.

J. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars[**;** zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

K. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 plain-steel bars.

L. Tie Bars: ASTM A 615/A 615M, Grade 60 deformed.

M. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

O. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

P. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type I, Supplement with the following:

    a. Fly Ash: ASTM C 618, Class C.
    b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33,

1. Maximum Coarse-Aggregate Size: **3/4 inch** nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: 1/2 to 3/4 inch nominal.

D. Water: Potable and complying with ASTM C 94/C 94M.

E. Air-Entraining Admixture: ASTM C 260.

F. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

A. Absorptive Cover: Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, non-load bearing] [Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch (3 to 6 mm).

2.6 CONCRETE MIXTURES

A. See Specification 033000, Cast in Place Concrete.

2.7 CONCRETE MIXING

A. See Specification 033000, Cast in Place Concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation**,** steel reinforcement**,** and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete..

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

K. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing as follows:

   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet-long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd**.** or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 31 13 – CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Chain-Link Fence Fabric
   2. Tension Wire
   3. Barbed Wire
   4. Chain-Link Fence Materials
   5. Gates

1.2 DEFINITIONS

A. CLFMI: Chain Link Fence Manufacturers Institute.

B. Zn-5-Al-MM Alloy: Zinc-5 percent aluminum-mischmetal alloy.

1.3 SUBMITTALS

A. Product Data: Material descriptions, construction details, dimensions of individual components and profiles, and finishes for the following:

   1. Fence and gate posts, rails, and fittings.
   2. Chain-link fabric, reinforcements, and attachments.
   3. Gates and hardware.
   4. Privacy slats.
   5. Barbed wire.
   6. Barbed tape.
   7. Gate operators, including operating instructions.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations for Chain-Link Fences and Gates: Obtain each color, grade, finish, type, and variety of component for chain-link fences and gates from one source with resources to provide chain-link fences and gates of consistent quality in appearance and physical properties.

1.5 PROJECT CONDITIONS

A. Field Measurements: Before commencing installation, verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Contractor shall furnish and erect fencing in locations indicated.

1. The fencing shall stand 7'-0" high when erected.
2. The 7'-0" height shall include 1'-0" height provided by extension arms and barbed wire.
3. Length of fencing shall be as indicated.

B. Fencing shall be complete with the following:

1. Fabric
2. Line posts
3. Corner and pull posts
4. Bracing
5. Top rails
6. Bottom tension wire
7. Gate posts
8. Truss bars
9. Gate
10. All fittings and accessories

2.2 CHAIN-LINK FENCE FABRIC

A. Fence fabric shall conform to the following requirements:

1. 6'-0" high.
2. Chain-link type.
3. 2" uniform square mesh.
4. Woven from No. 9 steel wire.
5. Helically wound and interwoven in such a manner as to provide a continuous mesh without knots or ties except in form of knuckling or of twisting and barbing the ends of wires to form the selvage of the fabric.
6. Top selvage shall be twisted and barbed. Bottom selvage shall be knuckled.

B. Fabric shall be zinc coated after weaving by the hot-dip galvanizing process.

C. Zinc for coating shall meet the requirements of ASTM Specification B6, and weight of coating shall be Class 2 in accordance with ASTM Specification A392 latest revision.

D. Zinc-coated steel chain-link fence fabric shall meet the requirements of ANSI/ASTM A392 latest revision.

2.3 TENSION WIRE

A. Tension wire shall conform to the following requirements:

1. Not less than No. 6 gage.
2. Meet the requirements of ANSI/ASTM Specification A 641 latest revision.

3. Be zinc coated.
    a. Weight of zinc coating shall be Class B.

2.4 BARBED WIRE

A. Barbed wire shall conform to the following requirements:

1. No. 12½ gage.
2. 4 point barbs at 5" o.c.
3. Meet the requirements of ANSI/ASTM Specification A 121 latest revision.
4. Be zinc coated.
    a. Weight of zinc coating shall be Class 3.

2.5 CHAIN-LINK FENCE MATERIALS

A. Pipe:

1. Pipe shall be cold rolled high strength steel (50,000 psi yield) made from steel strip meeting ASTM A-1011 requirements.
2. Pipe shall be zinc coated at a rate of 1 oz./ft^2.
3. Exterior coating shall consist of hot-dip galvanizing, chromate conversion, and a final coating of cross-linked acrylic polyurethane material.

B. Tube Sections:

1. Tubular sections shall meet the requirements of ASTM Specification ANSI/ASTM A500 or ANSI/ASTM A501.
2. Tubular sections shall be zinc coated in accordance with ANSI/ASTM A120-78.

C. Steel Shapes:

1. Steel shapes shall meet the requirements of ASTM Specifications ANSI/ASTM A36.
2. Appurtenant materials shall be in accordance with Table 1 of ANSI/ASTM A36.
3. Steel shapes shall be zinc coated in accordance with the requirements of ASTM Specification ANSI/ASTM A123.
4. Appurtenant materials, castings and miscellaneous hardware shall be zinc coated in accordance with the requirements of ASTM Specification ANSI/ASTM A153.
5. Miscellaneous hardware shall include the following:

    a. Post caps and tops
    b. Extension arms
    c. Fittings
    d. Pull bars
    e. Straps and bands
    f. Catches
    g. Clips
    h. Drop rods
    i. Yokes
    j. Connectors

D. Fencing components shall be in accordance with the following size table:

Rails	1.625" O.D. @ 1.83#/LF pipe or 1-5/8" x 1-¼ roll-formed section.
Line Posts	2.0" O.D. Pipe @ 2.28#/LF, or 1.875" x 1.625" x 1.625" x 0.113" H @ 2.70#/LF, or approved C-section posts.
Corner and Pull Posts	2.5" O.D. Pipe @ 3.11#/LF, or 2.5" x 2.5" Sq. Tubing @ 5.70#/LF.
Sliding Gate Posts	4" O.D. Pipe @ 9.11#/LF, Sch. 40.
Braces	1.625" O.D. Pipe @ 1.83#/LF, or 2" x 2" Sq. Tubing @ 3.85#/LF.
Sliding Gate Frame	2.5" O.D. Pipe top and bottom cross pieces, 2" O.D. uprights and tail section connected with fittings riveted each corner. Each frame shall be cross-braced with 3/8" Ø adjustable truss rods and connections.
Man Gate Frame	1.625" O.D. Pipe @ 1.83#/LF, or 2" x 2" Sq. Tubing @ 3.85#/LF; all frames cross-braced with 3/8" Ø truss rods and connections.
Swing Gate Frame	2.0" O.D. Pipe @ 2.72 #/LF, bracing 1.625" O.D. Pipe @ 2.27 #/LF. Gate leaves up to 8' wide shall have ⅜" Ø truss rods and connections. Gate leaves more than 8' wide shall have intermediate members and ⅜" Ø truss rods and connections.
Posts for Swing Gates	
Up to 6' width	2-7/8" O.D. Pipe @ 5.79#/LF, or 3-1/2" x 3-1/2" R-F Section @ 5.14#/LF.
Over 6' and up to 13'	4" O.D. Pipe @ 9.11#/LF.
Over 13' and up to 18'	6-5/8" O.D. Pipe @ 18.97#/LF.
Over 18'	8-5/8" O.D. Pipe @ 24.70#/LF.

2.6 SWING GATES

A. Swing gates shall conform to the following requirements:

1. Gate frames shall conform to Article 2.5.
2. Fabric shall be the same material used for the fencing.

B. Swing gate leaves shall have a minimum of two hinges. Hinges shall be steel or malleable iron 3 inches or more in width. Gate hinges shall be of a heavy pattern with large bearing surfaces. The number and arrangement of the hinges must be adequate to prevent gate leaf twisting and to permit operation by one person.

C. Swing gate latches shall be plunge-bar type and full gate height. Latches shall be designed to engage the plunge-bar catch and provide for padlocking capability. Plunge-bar catch shall be set in concrete flush with finished grade.

D. Swing gates shall be furnished with padlocks, Yale, Master, or equal keyed to match Owner's standard locks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by Owner's Representative.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.

B. All erection shall be performed by competent fencing mechanics.

1. The fencing shall be erected true, taut and straight in accordance with dimensions indicated.

C. The complete fencing assembly shall be completely connected and fastened, with no loose components.

D. The Contractor shall furnish and erect new fencing to replace any fencing damaged by his construction operations.

1. The replacement of fencing damaged by the Contractor's construction operations shall be at the expense of the Contractor and at no additional cost to the Owner.

E. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.

F. Post Setting: Set all posts in concrete footing. Protect portion of posts aboveground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Using mechanical devices to set line posts per ASTM F 567 is not permitted. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured.

1. Dimensions and Profile: As indicated on Drawings.
2. Exposed Concrete Footings: Extend concrete 2 inches above grade, smooth,

and crown to shed water.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 30 degrees or more.

B. Line Posts: Space line posts uniformly at 10 feet o.c.

C. Post Bracing Assemblies: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts. Locate horizontal braces at midheight of fabric on fences with top rail and at two-thirds fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

D. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.

1. Top Tension Wire: Install tension wire through post cap loops.
2. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same gage and type of wire.

E. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended by fencing manufacturer.

F. Intermediate Rails: Install in one piece at post-height center span spanning between posts, using fittings, special offset fittings, and accessories.

G. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to braces 24 inches o.c.

J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

K. Barbed Wire: Install barbed wire uniformly spaced angled toward security side of fence**.** Pull wire taut and install securely to extension arms and secure to end post or terminal arms.

3.5 GATE INSTALLATION

A. General: Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 32 31 13

SECTION 32 92 00 - LAWNS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Topsoil Placement and Preparation
2. Temporary Seeding
3. Permanent Seeding.
4. Sodding.
5. Mulching.

1.3 SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging, as well as the name and telephone number of supplier.

B. Qualification Data: For landscape Installer.

C. Planting Schedule: Indicating anticipated planting dates for each type of planting.

1.4 QUALITY ASSURANCE

A. Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment. Require Contractor to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

1.5 CONTRACTOR RESPONSIBILITIES

A. It shall be the responsibility of the Contractor to do each of the following:

1. Remove all rocks and other debris, furnish and install topsoil and otherwise prepare ground for planting.
2. Secure a satisfactory stand of grass of such uniformity and cover as to at least match what existed prior to his construction operations;
3. Secure a stand of grass such as will minimize loss of soil by erosion;
4. Maintain all seeded areas until final acceptance of the work including irrigation of approximately 1" per week.
5. Restore or replace any portion of the grassing work that is found to be defective, or which results in an unsatisfactory stand of grass, or which becomes damaged prior to acceptance of the work.
6. Should all other work at the site have been completed and accepted, and should the Contractor have removed all forces and equipment from the plant site, he shall nevertheless, in the event of failure or partial failure of the grassing work, be obliged under the terms of the Bond given to the Owner to return such forces and equipment to the plant site as are necessary to insure the satisfactory completion of this item of work under the Contract.
7. The Contractor shall dispose of excess material as specified herein above, and shall remove all rubbish and surplus construction materials from the site.
8. The Contractor shall restore all areas (including grassing, paving, landscaping, etc.) of which are affected by any of his construction operations to original condition or in accordance with these Specifications, whichever is the more stringent requirement. Final payment will not be made until such restoration is achieved to the satisfaction of the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones ½ or larger in any dimension and other extraneous materials harmful to plant growth.

1. Topsoil Source: Reuse surface soil, if any, stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

a. Amend existing in-place surface soil to produce topsoil meeting the requirements described above. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

b. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2. Contractor shall be responsible for furnishing a topsoil analysis for review by the Engineer unless the Contractor receives written permission to waive the requirement from the Engineer.
3. Contractor shall amend the topsoil to correct deficiencies based on the results of the test(s).

2.2 SEED

A. Seed shall meet the requirements of GDOT Specification Section 890.2.01 and seed shall be furnished and installed according to the tables in Section 700.

2.3 TURFGRASS SOD

A. Turfgrass Sod: Sod shall meet the requirements of GDOT Specification Section 890.2.02.

2.4 FERTILIZER AND MULCH

A. Fertilizer: Fertilizer shall meet the requirements of GDOT Specification Section 891.2.01.

1. Fertilizer shall be uniformly applied to all areas to be planted at the time of seeding or sodding; and the rate of application shall be a minimum of 900 lbs. of 13-13-13 per acre.
2. The rate of application shall be adjusted based on the results of soil tests.

B. Mulch: Mulch shall meet the requirements of GDOT Specification Section 893.2.02.

1. Mulch for hydroseeding shall consist of specially prepared wood cellulose or a natural wood fiber containing clean whole cut chips.
2. It shall be processed in such a manner that it will contain no growth or germination inhibiting factors and shall be dyed an appropriate color to facilitate a uniform spread of the slope by visual inspection.
3. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with fertilizers, grass seeds, water, and other additives, the fibers in the material will become uniformly suspended to form a homogenous slurry; and that when hydraulically sprayed on the ground, the material will form a blotter like ground cover impregnated uniformly with grass seed.
4. All such mixtures shall be used with eight (8) hours from time of mixing.

2.5 EROSION-CONTROL MATERIALS

A. Erosion Control Blankets or Netting: Blankets or netting shall meet the requirements of GDOT Specification Section 713.

B. Contractor shall meet all other erosion control measures as described elsewhere in the Contract Documents.

PART 3 - EXECUTION

3.1 GENERAL

A. Permanent grass seeding and mulching, or sodding, should be provided in all disturbed areas upon completion of grading and other construction activities.

B. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

D. Protect adjacent and adjoining areas from hydroseeding overspray.

E. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways in accordance with Division 2 Section “Site Clearing”.

3.2 SUBGRADE PREPARATION

A. Before placement of topsoil the subgrade shall be prepared as follows:

1. Shall be loosened to depth of not less than four (4) inches but not greater than eight (8) inches;
2. The surfaces shall be cleared of all rock one (1) inch or larger in size, all construction debris, or other objectionable material.

B. Limit lawn subgrade preparation to areas to be planted.

3.3 TOPSOIL PLACEMENT

A. The topsoil, previously removed and stored, shall then be placed over the prepared subgrade.

B. The depth of the topsoil shall be sufficient to allow for natural settlement, so that after such settlement has taken place the surface of the topsoil layer will conform to the finished elevations and contours shown on the Drawings.

C. After placement of topsoil the surface shall be raked to remove clods, stones over one (1) inch in diameter, brush, roots, construction debris, or other objectionable material.

D. Should the stockpile of topsoil accumulated from the trenching operations not be adequate for supplying the quantities of topsoil required for preparation of the areas described herein above, the Contractor shall furnish, at his expense, topsoil from other sources to meet any deficiencies.

E. The Contractor shall not proceed with grassing work until receipt of written approval of topsoil preparation and confirmation of topsoil depth by Engineer. All rocks and debris must be removed from topsoil prior to beginning grassing work.

3.4 TOPSOIL PREPARATION

A. Topsoil preparation shall be performed immediately prior to seeding, and shall consist of the following:

1. Loosening of the topsoil by discing, harrowing or other approved methods.
2. On areas having a slope of 3:1 or flatter, the topsoil shall be loosened to a depth of approximately three (3) inches;
3. On slopes steeper than 3:1, the topsoil shall be merely roughened to a depth of approximately one (1) inch.
4. All clods and other foreign materials which are larger than one (1) inch in any dimension shall be removed.
5. All rocks ½ inch or larger shall be removed.
6. All gullies and washes that develop in the loosened topsoil prior to seeding shall be repaired.
7. Seeding shall immediately follow soil preparation so as to avoid both compaction and/or wash by heavy rainfall and crust formation by sunbaking.
8. Seeding will not be permitted on hard or crusted topsoil surfaces.

B. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least of 6 inches. Prepare soil as described for topsoil in Part 2 of this specification.
3. Till soil to a homogeneous mixture of fine texture.
4. Remove stones larger than 1 inch in any dimension and remove sticks, roots, trash, and other extraneous matter.
5. Legally dispose of waste material, including grass, vegetation, and turf, off of Owner's property unless specific written permission is received from Owner for on-site disposal.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

D. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.5 SEEDING

A. Seeding: Seeding shall meet the requirements of GDOT Specification Section 700.

3.6 HYDROSEEDING

A. Hydroseeding: Hydroseeding shall meet requirements of GDOT Specification Section 700.

B. Hydroseeding shall be accomplished with approved equipment, and all mixtures shall be constantly agitated from the time that they are mixed until they are finally applied to the seed bed.

C. Nozzles or sprays shall not be directed toward the ground in such a manner as to cause erosion or runoff.

D. One-step Process: Apply slurry uniformly to all areas to be seeded. Apply mulch at a minimum rate of 1500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

E. Two-step Process: Apply slurry uniformly to all areas to be seeded. Apply first slurry application at a minimum rate of 500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1000 lb/acre.

3.7 SOLID SODDING

A. Solid Sodding: Solid Sodding shall meet the requirements of GDOT Specification Section 700.

B. Do not lay sod if dormant or if ground is frozen or muddy.

C. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

D. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 MULCHING

A. Mulching: Mulching shall meet the requirements of GDOT Specification Section 700.

B. When hay or straw is used for mulch, it shall conform to the following requirements:

1. It shall be spread over all seeded areas at the rate of approximately two (2) tons per acre.
2. It shall be applied to a uniform depth by an approved method, and in such a manner that not more than ten (10) percent of the soil surface is exposed.
3. The use of wet hay or straw will not be permitted.
4. Mulch shall be applied within 48 hours after the seeding operation.
5. Mulch shall be anchored to the seeded surface by discing or punching the mulch partially into the soil, by use of approved netting, or by use of other methods or materials approved by the Engineer.

3.9 FERTILIZING

A. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

1. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
2. Mix lime with dry soil before mixing fertilizer.

B. Fertilizer shall be uniformly applied to the designated area at the time of seeding; and rate of application shall be 900 lbs. of 13-13-13 per acre.

C. Fertilizer shall be applied using any approved method.

1. If liquid fertilizer should be used, it shall be kept agitated during application and shall be applied in amounts sufficient to provide the same value of nutrients per acre as that specified for dry fertilizer.
2. Should the Contractor elect to use liquid fertilizer in a hydroseeder, the materials shall be applied on a poundage basis, mixed with the same volume of water that would be used with dry fertilizer.

3.10 TEMPORARY GRASSING

A. Areas, sections, or portions of the work site within which construction work has been completed prior to beginning of final grading and grassing, shall be protected from erosion by employment of temporary control measures such as seeding and mulching or seeding and netting. Temporary grass seeding and mulching is required in disturbed areas that are unused for extended periods of time.

B. All temporary erosion control and pollution control features installed by the Contractor shall be maintained by the Contractor until the site is ready for final grading and grassing.

C. Temporary grassing required to be removed so as to permit the performance of final grading and grassing work shall be removed and ground preparation for final grassing shall be undertaken immediately after the removal of temporary grassing or other temporary erosion control measures.

D. The Contractor must maintain temporary grassing under all circumstances until the installation of permanent grassing.

3.11 LAWN RENOVATION

A. Renovate existing lawn(s) including lawns damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
2. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.
3. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.
4. Mow, dethatch, core aerate, and rake existing lawn.

5. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
6. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
7. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
8. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.

B. Where existing lawns consist of bermuda, zoysia, centipede or other types of lawn grasses, the top soil shall be dressed and fertilized, and the top of the trench shall be covered with sod of the same type as that removed.

C. Other areas such as raw land, undeveloped areas, pastureland, grassed areas, etc., shall be seeded and mulched.

D. Water newly planted areas and keep moist until new lawn is established.

3.12 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: 60 days from date of Substantial Completion; When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
2. Sodded Lawns: 30 days from date of Substantial Completion.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

C. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

D. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

E. Water lawn at a minimum rate of 1 inch per week.

F. Mow lawn as soon as grass blades reach 4 inches in length, or as appropriate for specific types of grass. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height until project is accepted by Owner. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.

G. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry. Use fertilizer that will provide actual nitrogen of at least 1 lb per 1,000 sq. ft. to lawn area.

3.13 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of rocks, weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of rocks, weeds, open joints, bare areas, and surface irregularities.

C. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.14 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 33 11 14 - METAL PIPE AND FITTINGS FOR SEWERAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for Metal pipe and fittings including the following:

1. Ductile Iron pipe and fittings.
2. Stainless steel pipe.
3. Stainless steel tubing.
4. Steel pipe.
5. Cast iron soil pipe.
6. Mechanical couplings.
7. Gripper glands.
8. Polyethylene encasement.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include the following:

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.4 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall provide the proper equipment, tools and facilities necessary for the efficient prosecution of the work.

1. Materials damaged in unloading, handling or installation shall be promptly discarded and removed from the area of the work.
2. No pipe shall be unloaded or moved by allowing the pipe to roll, slide or fall to the ground or to cushions placed on the ground.
3. No pipe, fittings, valves, etc., shall be unloaded by inserting loader blades, teeth,

etc., into the pipe interior.

B. Pipe shall be stored on racks or timbers in such a manner that pipe ends are above the ground surface.

1. When pipe is to be moved it shall not be dragged or rolled but shall be lifted by use of a sling designed to prevent damage to the pipe coatings.
2. Should an intermediate placement of the pipe along the side of the trench be required, the pipe shall be placed on racks or timbers along the side of the trench in manner as specified hereinabove.

C. Each length or section of pipe shall be cleaned immediately before being placed in the trench and joined.

1. Cleaning shall be accomplished by use of a tight swab or other suitable cleaning device.
2. If necessary, a brush pig shall be run through the section of pipe prior to final swabbing.
3. Pipe ends shall be wiped clean before the pipe is joined.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ductile Iron Pipe:

1. American
2. U.S. Pipe and Foundry Company
3. McWane

B. Ductile Iron Fittings:

1. American
2. U.S. Pipe and Foundry Company
3. McWane
4. Tyler

C. Restraining Gaskets:

1. Field-lok gaskets as manufactured by U.S. Pipe and Foundry Company
2. Fast-grip gaskets as manufactured by American Cast Iron Pipe Company
3. Approved Equivalent.

D. Gripper (Restraining) Glands

1. "MJ gripper gland" manufactured by U.S. Pipe and Foundry Company
2. "MegaLug" manufactured by Ebaa Iron, Inc.
3. Approved Equivalent

E. Meter Boxes
1. Ford Meter Box Company.

2. Approved Equivalent.

F. Mechanical Couplings

1. Smith Blair
2. Dresser
3. Dependo-Lok
4. Approved Equivalent.

2.2 PIPE MATERIALS AND FITTINGS

A. The Contractor shall carefully examine all pipe and piping materials before placing them in the work.

1. If any such pipe or materials should be found to be defective, the Contractor shall promptly notify the Engineer and discard such pipe and materials.

B. The interior of all pipe, fittings, valves and accessories shall be kept free from dirt and foreign material.

1. Suitable bulkheads shall be used to block or plug ends of piping at the close of each work day and when work on a particular section of piping is temporarily discontinued.
2. Should dirt, mud, concrete, latence, paint or other foreign materials be allowed to enter the piping or any section of piping, such piping or section of piping shall immediately be cleaned.

C. Piping materials shall be of the types, classes and sizes as shown or as specified in the piping schedule.

2.3 DUCTILE IRON PIPE AND FITTINGS

A. Ductile Iron pipe shall be manufactured in accordance with requirements of ANSI A21.51 / AWWA C151.

B. Where ductile iron pipe and fittings are equipped with push-on joints, such joints shall conform to the requirements of ANSI A21.11 / AWWA C111 latest revision.

C. Where ductile iron pipe and fittings are equipped with mechanical joints, such joints shall conform to the requirements of ANSI A21.11 / AWWA C111 latest revision.

D. All pipe and fittings shall be furnished new from the manufacturer. No recoated or reconditioned pipe will be acceptable.

E. Gaskets

1. Gaskets for flanged, mechanical joint restrained joint, and push-on ductile iron pipe shall meet the requirements of ANSI/AWWA Specification ANSI A21.11/AWWA C111 latest revision.
2. Gasket materials for various service conditions shall be as follows:

a. Air and Water service (up to 120°F) - Synthetic Rubber
b. Air and Water service (120°F to 200°F) - Neoprene
c. Wastewater Service - Styrene Butadine Copolymer (SBR)

F. Pipe

1. In general, ductile iron pipe shall be furnished with push-on joints for buried applications and flanged joints for exposed, above grade applications, unless otherwise shown on Drawings.
2. Ductile iron flanged pipe shall conform to the following requirements:

    a. Shall be manufactured in accordance with the requirements of ANSI A21.15 AWWA C115 latest revision.
    b. Barrels of flanged pipe shall be ductile iron ANSI A21.51/AWWA C151.
    c. Flanges shall be in accordance with ANSI A21.15/AWWA C115 latest revision, and shall have chemical and physical properties specified for ductile-iron fittings under ANSI A21.10/AWWA C110 latest revision.
    d. Pipe and threaded flanges shall meet the requirements of ANSI A21.15 /AWWA C150, latest revision.
    e. Where flanges are cast on ductile-iron pipe they shall conform to ANSI A21.10/AWWA C110 latest revision and shall be ductile-iron as specified for threaded flanges.
    f. All flanges shall be rated for 250 psi working pressure; and the bolt circle and bolt holes shall match those of ANSI B16.1 Class 125 flanges and ANSI B16.5 Class 150 flanges.
    g. Flanged piping connecting to equipment shall have flanges that are compatible with the particular items of equipment to which they are attached.

G. Fittings

1. In general, fittings for use with push-on joint pipe shall be push-on joint unless otherwise shown on the Drawings.
2. Flanged fittings shall have flanges suitable for use with the type of flanged pipe and equipment to which they are connected, and flanges shall meet the requirements stated hereinabove for ductile iron pipe flanges.

    a. Fittings for use with flanged pipe shall conform to the requirements of ANSI A21.10 / AWWA C110 and shall have chemical and physical properties specified for ductile iron under ANSI A21.10 / AWWA C110.
    b. All flanges shall be rated for 250 psi working pressures; and the bolt circle and bolt holes shall match those of ANSI B16.1 Class 125 flanges and ANSI B16.5 Class 150 flanges.

3. All fittings shall be new. No reconditioned or recoated fittings shall be acceptable.
4. The Contractor may elect to use grooved end joints conforming to ANSI A21.10/AWWA C606 in lieu of flanged joints. The Contractor shall be responsible for making all revisions necessary for a complete installation which is similar in function to a flanged piping system.
5. Couplings for use with grooved end joints shall be ductile iron in accordance with

ASTM 536, Grade 65-45-12.

a. Gaskets shall be the center leg design manufactured of a nitrile compound.
b. Bolts shall be track head design and manufactured in accordance with ASTM A-183, minimum tensile 110,000 psi.
c. Couplings shall be Victaulic, or equivalent.

6. Bolting shall conform to Table 10.14 of ANSI A21.10 / AWWA C110 or ANSI A21.15 / AWWA C115 as applicable.

a. Bolts for use with flat ring type gaskets between gray iron flanges shall conform to the requirements of ASTM A 307-84, Grade B, hex head; and nuts shall be hex type of same grade and finish as the bolts.
b. Bolts for use with flat full-face type gaskets between either gray iron flanges or ductile iron flanges shall conform to the requirements of ASTM A449-84a, Type 1 hex head; and nuts shall be hex type of same grade and finish as the bolts.
c. Bolts shall conform to the requirements of ANSI B18.2.1, and nuts shall conform to the requirements of ANSI B18.2.2.

7. Wall pipes shall either be statically cast or fabricated from centrifugally cast ductile iron pipe.
8. Flanges shall be provided in between the ends of the wall pipe to serve as a thrust collar and/or water stop, as required.
9. For fabricated wall pipes, the space between the thrust collar or water stop shall be sealed by full welding on each side.
10. Gaskets for flanged joints shall be of materials as specified herein for various service conditions.

a. Gaskets shall be 1/8" thick, unless otherwise specified and/or indicated for special conditions, and shall conform to dimensions as given in Table A.1 of Appendix A to ANSI A21.15 / AWWA C115 or Table A.1 of Appendix A to ANSI A21.10 / AWWA C110 latest revision or as applicable.
b. Gaskets shall be flat ring type and flat full-face type according to service conditions.
c. Flat ring type shall not be used where working pressures exceed 50 psi.

11. Fittings for use with push-on or mechanical joint pipe shall be compact or full bodies, and shall conform to the requirements of ANSI A21.10/AWWA C110, latest revision or ANSI A21.53/AWWA C153, latest revision.
12. Fittings meeting the requirements of C110 may be either gray iron or ductile iron where working pressures are less than 250 psi; where working pressures exceed 250 psi, fittings shall be ductile iron.
13. Fittings meeting the requirements of C153 shall be ductile iron in all situations.

H. Coatings

1. All ductile iron pipe and fittings shall be furnished with interior lining.
2. The types of lining required for the various conditions of service are listed herein below.

a. Wastewater service - Cement lining in accordance with ANSI A21.4/AWWA C104 latest revision; standard thickness with asphaltic seal coat.
b. Air Service - Unlined, or approved lining recommended by manufacturer.

3. Ductile iron pipe for air service shall be furnished with coal tar epoxy lining (16 mils dry film thickness) suitable for temperatures up to 250^{o}F, or other equivalent lining as recommended by pipe manufacturer.
4. Ductile iron pipe for sewage or process forcemains shall be furnished with Protecto 401 lining or equivalent.
5. All ductile iron pipe and fittings, including pipe and fittings to be submerged in liquids, shall be tar-coated outside except when installed in particular locations as hereinafter specified:

    a. Ductile iron pipe installed in buildings, galleries, vaults or other similar structures or locations where the piping is to be permanently exposed and specified to be painted, shall be furnished with exterior coat of rust-inhibitive primer suitable for application of finish coating as specified in these Specifications.
    b. Ductile iron or gray iron wall-pipes, wall-sleeves or other wall-fittings, and fittings to be encased in concrete, shall be furnished "bare" (without tar-coat).
    c. Ductile iron pipe, where passing through concrete walls, shall have exterior tar-coat removed from that length of the pipe to be encased in the wall.

6. Ductile iron pipe to be installed underground shall be furnished with outside asphaltic coating of 1 mil thickness per ANSI A21.51 / AWWA C151.

I. Quality Control

1. All testing work specified in this section shall be performed by the supplier.
2. The manufacturer shall perform all tests in house as part of their quality assurance/quality control.
3. Test results shall be submitted to the Engineer in accordance with requirements of this section.
4. All pipe shall receive a hydrostatic proof test of 500 psi for a minimum duration of 10 seconds.

    a. Each test cycle shall be recorded on a strip chart.
    b. Each test cycle for pipe 18 inches and greater shall be marked by pipe number.
    c. Each pipe shall be inspected for leaks and pipes which contain evidence of hydrostatic leak shall be scrapped.
    d. Repair welding of hydrostatic leaks is not permitted.

5. Tensile test specimens shall be cut from the midsection of the pipe wall.

    a. These specimens shall be machined and tested at least every three hours in accordance with ASTM E-8, and ASTM A-370 where applicable, using the halt of pointer or 0.2% offset method.
    b. Pipe failing to meet the minimum requirements of these standards shall be

rejected.

c. Adjacent test samples shall be made available to the Owner’s independent testing laboratory upon the Owner’s request.

6. Charpy impact samples shall be taken during each hour of production. Samples shall be selected to properly represent extremes of pipe diameters and wall thickness.

7. Impact tests shall be conducted in accordance with ASTM E-23.

   a. Impact strengths on samples shall be 7 ft.-lb minimum for tests conducted at $70^{o}\pm10$.
   b. In addition, adjacent specimens shall be taken and made available to the Owner's laboratory for independent testing upon the Owner's request.

8. Each end of each pipe (each pipe socket and pipe spigot) shall be measured and shall conform to the standard dimensions of ANSI A-21.51 (AWWA C-151).

   a. In addition, each socket and spigot shall be inspected in a well-lighted area for injurious defects which could affect joint performance.
   b. Such defects may be removed by cutting off pipe ends.
   c. Pipe with injurious defects in the bell must be scrapped.

9. The Owner or his designated inspection agency shall have access to all areas of the pipe manufacturer's plant during production, inspection, and shipping and shall have the opportunity to witness all tests associated with production and inspection of pipe and fittings for any given pipe order. Reasonable facilities shall be provided for this purpose.

10. The Contractor shall provide manufacturers' certifications that all ductile iron pipe and fittings meet provisions of this section and meet requirements of ANSI A21.51 (AWWA C-151).

    a. Product certification shall include tensile and Charpy test results which shall be traceable to pipe numbers and testing periods.
    b. For pipe sizes 18 inches and greater, hydrostatic test charts including pipe numbers for each test cycle shall be furnished as part of the certification test reports.
    c. Chemical analysis shall be furnished for each ladle of iron which will cover each pipe cast and must correlate with the mechanical test results.
    d. For pipe sizes 18 inches and greater, complete traceability is required throughout the certification process and must be clearly legible on each pipe at the point of installation.

11. The Contractor shall provide certifications that all pipe joints have been tested and meet requirements of ANSI A21.11 (AWWA C-151).

J. Quality Control

1. All testing work specified in this section shall be performed by the supplier.

2. The manufacturer shall perform all tests in house as part of their quality assurance/quality control.
3. Test results shall be submitted to the Engineer in accordance with requirements of this section.
4. Each pipe in the size range 4"-16" shall receive a hydrostatic proof test of 500 psi for a minimum duration of 15 seconds.
5. Each pipe in the size range 18" and greater shall receive a hydrostatic test not less than 85% of the specified minimum yield strength for a duration of not less than 15 seconds.
6. Each test cycle shall be recorded on a strip chart.
7. Each test cycle for pipe 18" and greater shall be marked by pipe number.
8. Each pipe shall be inspected for leaks.
9. Pipes which contain evidence of hydrostatic leak shall be scrapped.
10. Repair welding of hydro-leaks is not permitted.
11. Tensile test specimens shall be cut longitudinally from the midsection of the pipe wall.

    a. These Specimens shall be machined and tested at least every three hours in accordance with ASTM E-8, and ASTM A-370 where applicable, using the 0.2% offset method.
    b. Brinell hardness tests shall be performed at the same frequency as the tensile test and shall meet a maximum Brinell hardness of 230.
    c. Pipe failing to meet the minimum requirements of these standards shall be rejected.
    d. Adjacent test samples shall be made available to the Owner’s independent testing laboratory upon Owner’s request.

12. Charpy impact samples shall be taken during each hour of production. Samples shall be selected to properly represent extremes of pipe diameters and wall thickness.

13. Impact tests shall be conducted in accordance with ASTM E-23.

    a. Impact strengths on samples shall be 8 ft.-lb minimum for tests conducted at 70^{o}±10.
    b. In addition, adjacent specimens shall be taken and made available to the Owner's laboratory for independent testing upon the Owner's request.

14. Each end of each pipe (each pipe socket and pipe spigot) shall be measured and shall conform to the standard dimensions of ANSI A-21.51 (AWWA C-151).

    a. In addition, each socket and spigot shall be inspected in a well-lighted area for injurious defects which could affect joint performance.
    b. Such defects may be removed by cutting off pipe ends.
    c. Pipe with injurious defects in the bell must be scrapped.

15. The Owner or his designated inspection agency shall have access to all areas of the pipe manufacturer's plant during production, inspection, and shipping and shall have the opportunity to witness all tests associated with production and inspection of pipe and fittings for any given pipe order. Reasonable facilities shall be provided

for this purpose.

16. The Contractor shall provide manufacturers' certifications that all ductile iron pipe and fittings meet provisions of this section and meet requirements of ANSI A21.51 (AWWA C-151).
    a. Product certification shall include tensile and Charpy test results which shall be traceable to pipe numbers and testing periods.
    b. For pipe sizes 18 inches and greater, hydrostatic test charts including pipe numbers for each test cycle shall be furnished as part of the certification test reports.
    c. Chemical analysis shall be furnished for each ladle of iron which will cover each pipe cast and must correlate with the mechanical test results.
    d. For pipe sizes 18 inches and greater, complete traceability is required throughout the certification process and must be clearly legible on each pipe at the point of installation.

17. The Contractor shall provide certifications that all pipe joints have been tested and meet requirements of ANSI A21.11 (AWWA C-151).

K. Restrained Joint Pipe.

1. The following types of restrained joint pipe will be acceptable:

    a. Flexible, restrained push-on type where joints incorporate ductile iron locking segments, inserted through slots in the bell face, providing a positive axial lock between the bell interior surface and a retainer weldment on the spigot end of the pipe.
    b. Restraining gaskets for push-on pipe and fittings 4" through 12" diameter. Restraining gaskets shall contain stainless steel locking segments vulcanized into the gasket which shall in all other respects meet the requirements of standard push-on gaskets in ANSI/AWWA C111/A21.11. Restraining gaskets shall be UL listed for a minimum working pressure of 250 psi.
    c. Gripper glands may be used with mechanical joint fittings. Joint restraint shall be provided by a follower gland with mechanism that grips pipe with teeth which are wedged tighter as pressure is applied to the pipeline. Gripper glands shall have a working pressure rating of at least 350 psi up to 16" size and at least 250 psi up to 48" size. Gland shall conform to mechanical joint (ANSI/AWWA a21.11) and be suitable for use with tee-head bolts (ANSI/AWWA c153/a21.5).

2. Maximum allowable deflections shall be per manufacturer’s published recommendation.
3. Use of set screws bearing on the pipe wall will not be acceptable except where retainer glands are to be used.

L. Markings

1. Each length or piece of pipe shall be bar coded and clearly marked as to type and class with different colors being used to distinguish between classes.
2. Where the drawings indicate that between specified stations a particular class of

pipe will be required, the Contractor will not be permitted to store or string pipe of other classes than that specified for the particular section of the transmission mains.

2.4 STAINLESS STEEL PIPE

A. Stainless steel pipe shall conform to the requirements of ANSI/ASTM A778, latest revision, Grade TP 304.

B. Stainless steel pipe shall be furnished in accordance with nominal pipe sizes and nominal wall thicknesses given in Table 1 of the American National Standard for Stainless Steel Pipe (ANSI B36.19, latest revision).

C. Pipe sizes and Schedules (nominal wall thicknesses) shall be as indicated, but in no case shall they be less than Schedule 10. Flanges, nuts and bolts shall also be made of stainless steel unless otherwise specifically shown on Drawings.

D. All fittings shall be forged fittings unless otherwise specifically shown on the Drawings.

E. Flanged pipe ends shall be made of type 304L stainless steel slip-on type rolled angel face rings and stainless steel back-up flanges drilled to ANSI 16.1 class 125 standard. The angle face ring thickness shall be continuously welded on both sides to the pipe or fitting. The angle leg shall not interfere with the flange bolt holes.

2.5 STAINLESS STEEL TUBING

A. Stainless steel tubing shall conform to the requirements of ANSI/ASTM A269, latest revision, Grade TP 304 or Grade TP 316.

B. Each length of tube shall be tested by the manufacturer in accordance with ANSI/ASTM A450, latest revision.

2.6 STEEL PIPE

A. Steel pipe shall conform to the requirements of ASTM Specification Designation A 53, for black and hot-dipped galvanized seamless steel pipe, 'standard weight.'

B. Pipe for use in buildings shall be furnished with threaded ends for use with threaded malleable iron fittings (black) and unions.

C. Pipe installed underground shall have welded joints and shall be equipped with protective covering mechanically applied in a factory or, where approved by the Engineer, in a field plant especially equipped for pipe coating application.

D. Specials and fittings which cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant applying the protective covering to the pipe.

E. Joints shall be coated and wrapped by hand after welding has been completed, welds inspected, and pipe tested.

F. All hand coating and wrapping shall be done in a manner and with materials that will produce a covering equal in effectiveness to that of the mechanically applied covering.

G. The pipe covering shall consist of coal-tar priming coat, coat of coal tar enamel, wrapper of felt, and a wrapper of kraft paper or coat of water resistant white paint (wash).

H. The coatings and wrappings shall be applied in the order named hereinabove, and all materials and procedure shall conform to the requirements of AWWA Specification C204, except that interior lining will not be required.

I. Where steel pipe is specified to be furnished galvanized the protective covering will not be required.

2.7 MECHANICAL COUPLINGS

A. Pipe couplings shall be threaded, push-on mechanical joint, or bolted as specified herein or as indicated.

B. Harness bolts, where required on lines under pressure where shown shall be one of the following:

1. Joint restraint system as manufactured by Star National Products.
2. Standard system of the pipe manufacturer.
3. Approved equivalent.

C. Mechanical couplings shall be carefully installed in accordance with the manufacturer's recommendations.

1. A space of at least ¼ inch and not more than one inch shall be left between the pipe ends.
2. Pipe and coupling surfaces which contact gaskets shall be clean and free from dirt and other foreign matter during assembly.
3. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks and all parts of the coupling are square and symmetrical with the pipe.
4. Following installation of the coupling, damage areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of the Engineer.
5. The interior surfaces of the middle rings shall be prepared for painting in accordance with instructions of the paint manufacturer and shall then be coated with liquid epoxy in accordance with AWWA C210.
6. The remaining components shall be cleaned and shop primed with the manufacturer's standard rust-inhibitive primer.

2.8 GRIPPER GLANDS

A. Where gripper glands are indicated for use with mechanical joint fittings, joint restraint shall be provided by a follower gland with a mechanism that grips the pipe with teeth which are wedged tighter as pressure is applied to the pipeline.

B. Gripper gland shall have a working pressure rating of at least 350 psi up to 16" size and at least 250 psi up to 48" size.

C. Gland shall conform to mechanical joint (ANSI/AWWA A21.11) and be suitable for use with tee-head bolts (ANSI/AWWA C153/A21.53).

D. Gripper gland shall be one of the following:

1. "MJ Gripper Gland" manufactured by U.S. Pipe and Foundry Company.
2. "Mega Lug" manufactured by EBAA Iron, Inc.
3. Approved equivalent.

2.9 POLYETHYLENE ENCASEMENT.

A. Polyethylene plastic wrap manufactured for the protection of ductile iron pipe.

B. The polyethylene wrap shall have a minimum thickness of 8 mils (0.008 in.).

C. The wrap shall meet the requirements of AWWA C105 and shall be constructed from virgin polyethylene material conforming to the requirements of ANSI/ASTM Specification D1248.

D. Polyethylene wrap shall be sealed using heavy duty duct type tape or other method recommended by the manufacturer to create a watertight encasement of the ductile iron pipe.

1. To prevent the polyethylene wrap from being torn or otherwise damaged by backfill material the polyethylene wrapped pipe shall be first backfilled with sand to a depth of at least 6 inches below the bottom, around the sides, and over the top of the pipe.

2.10 JOINING MATERIALS

A. Transition Couplings for Underground Piping, NPS 1-1/2 and Smaller:

1. Shall be manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Transition Couplings for Underground Piping, NPS 2 and Larger:

1. Shall conform to AWWA C219.
2. Shall be metal, sleeve-type coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Transition Couplings for Aboveground or Vault Piping:

1. Pipe fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

D. Brazing Filler Metals:

1. Shall be AWS A5.8, BCuP Series.

E. Soldering Flux:

1. Shall conform to ASTM B 813.
2. Shall be water-flushable type.

F. Solder Filler Metal:

1. Shall conform to ASTM B 32.
2. Shall be lead-free type with 0.20 percent maximum lead content.

G. Plastic Pipe-Flange Gasket, Bolts, and Nuts:

1. Shall be the type and material recommended by piping system manufacturer, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTILE IRON PIPE

A. The Contractor will not be permitted to cut nipples from ungauged pipe in order to make connections.

1. If the Contractor desires to cut lengths in the field to make up the line, he shall make such cuts from lengths of pipe having exterior of barrel fully gauged to fit bell of pipe of that class.

B. The permissible depth of cover over a pipe of particular size and class is based upon the following:

1. The trench excavation work being performed by the Contractor in accordance with the requirements of these Specifications.
2. The bedding and backfill materials being furnished by the Contractor in accordance with the requirements of these Specifications.
3. The placement of bedding and backfill material being performed by the Contractor in accordance with the requirements of these Specifications.

C. Should the Contractor fail to perform the trench excavation work, or the furnishing and placement of bedding and backfill, or the pipelaying work in accordance with the requirements of these Specifications, he/she will be required to remedy the work by furnishing and placing or installing other materials as may be determined by the Engineer as being necessary to remedy that work not performed in accordance with these Specifications and thereby secure work of the quality specified.

D. Buried ductile iron pipe for all applications shall be furnished and installed in trenches in various locations along the pipeline(s) as indicated and described herein. Pipe thickness and/or class shall meet requirements and recommendations of the manufacturer and ANSI/AWWA C151/A21.51 for depth of cover, working pressure and laying conditions when classes of pipe and depths of cut are not indicated elsewhere.

SCHEDULE OF PERMISSIBLE COVER
OVER GRAVITY DUCTILE IRON PIPE SEWER PIPES
ANSI/AWWA C151/A21.51

	DEPTHS OF COVER IN FEET OF CLASSES OF PIPE OF GIVEN SIZE				
Pipe Size Inches	Thickness Cl. 52	Thickness. Cl. 53	Thickness. Cl. 54	Thickness. Cl. 55	Thickness Cl. 56
8	62	82	100	100	100
10	47	59	74	86	100
12	41	49	59	71	83
14	34	41	49	57	67
16	30	36	41	47	55
18	27	31	36	41	47
20	25	28	32	37	41
24	21	24	27	30	34
30	19	21	24	27	31
36	19	21	25	28	31
42	18	22	24	28	31
48	18	21	24	28	31
54	17	21	25	28	32

SCHEDULE OF REQUIRED WALL THICKNESSES FOR PRESSURE PIPING DUCTILE IRON PIPE ANSI A21.51, GRADE 60-42-10	
Pipe Size (Inches)	Cover not Exceeding 16' Wall Thickness
4	0.29"
6	0.31"
8	0.33"
10	0.35"
12	0.37"
14	0.39"
16	0.40"
18	0.41"
20	0.42"
24	0.44"
30	0.47"
36	0.53"
42	0.59"
48	0.65"
54	0.73"

3.2 JOINING OF PIPE

A. Pipe joining procedure shall be in accordance with these Specifications and in accordance with the recommendations of the manufacturer of the particular type of joint.

B. Ductile Iron Pipe

1. Mechanical Joint Pipe

a. The joining of mechanical joint pipe shall be performed in accordance with AWWA standard for installation of Cast Iron Water Mains C600.
b. The ends of the two pieces of pipe to be joined shall first be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter, and

then lubricated prior to joining glands shall be slipped on the spigot end of the pipe with the lip extension of the gland toward the socket end.

c. The rubber gasket shall be lubricated and placed on the spigot end with the thick edge toward the gland.
d. The entire section of the pipe shall be pushed forward to seat the spigot end in the bell.
e. The gasket shall then be pressed in place within the bell, care being taken to locate the gasket evenly around the entire joint.
f. The cast iron gland shall be moved along the pipe into position for bolting; all the bolts shall be inserted, and hard tightened.
g. All nuts shall then be tightened with a suitable torque-limiting wrench.
h. The torque for various sizes of bolts shall be per the manufacturer's recommendations.
i. Nuts spaced 100 to 180 degrees apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland.

2. Push-On Joint Pipe

a. The joining of Push-on joint pipe shall be performed in accordance with the AWWA Standard for Installation of Cast Iron Water Mains C600 and in accordance with the manufacturer's instructions and/or recommendations for the particular joint furnished.
b. The inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating and other foreign matter.
c. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the socket.
d. A thin coat of gasket lubricant shall be applied to either the inside surface of the gasket or outside surface of the spigot, or both.
e. Gasket lubricant shall be as supplied by the particular manufacturer and reviewed by the Engineer.
f. The spigot end of the pipe shall be carefully inserted in the socket so that the joining surfaces will not come in contact with the ground, trench bed or trench sides.
g. The joint shall then be completed by forcing the spigot end to the bottom of socket by methods as recommended by the particular manufacturer and concurred with by the Engineer.
h. All pipe shall be furnished with a depth mark to indicate a 'full-home' assembly.
i. The Contractor shall provide special transition sleeves or transition pieces of pipe for connecting pipe of different classes; and those special pieces shall be clearly identified with suitable marking.
j. If the Contractor desires to cut lengths in the field to make closures, he shall have on hand an adequate number of lengths of pipe of the various classes having the exterior of the barrel gauged to fit the socket of pipe.

3. Restrained Joint Pipe

a. Joints and pipe ends for restrained joint pipe shall be prepared and installed in accordance with the pipe manufacturer's recommendations.

4. Flanged Pipe

    a. The joining of flanged ductile iron pipe shall be in accordance with the requirements of ANSI B31.1.0.
    b. All bolt holes shall so match as to permit free insertion of bolts without binding.
    c. Faces of flanges shall match fully and shall be true both horizontally and vertically before the bolts are tightened.
    d. Any misalignment or vertical deviation from a true match shall not be corrected by tightening the bolts but shall be remedied by adjustment of the piping.
    e. The same requirements shall apply for connection of flanged pipe to flanged equipment.
    f. Gaskets shall be suitable for the particular class of flanges with which the pipe is equipped, and the entire piping system shall be leak-proof.

3.3 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. Ductile-Iron Sewer Pipe with Ductile-Iron Fittings: According to AWWA C600.

C. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.4 ELECTRICAL BONDING OF DUCTILE IRON PIPE JOINTS

A. Electrical bonding of ductile iron pipe shall be accomplished using the thermite weld method as recommended by the Ductile Iron Pipe Research Association.

1. Thermite welding is commonly referred to by the trade names Caldweld^{R} or ThermOweld which is a fusion type weld of a conductor to a ferrous metal surface.
2. The thermite weld connection shall be made using weld metal and a mold housing in accordance with the manufacturer's requirements.
3. The size of the thermite weld charge and mold housing shall be as required by the manufacture for the size of conductor and diameter of pipe which is involved.

B. The wire used to electrically bond the pipe joints shall be a copper cathodic protection conductor.

1. The wire shall be stranded copper wire with a high molecular polyethylene or equivalent type insulation.
2. The length of the joint bond shall be sufficient to withstand movement of the joint due to expansive soils and/or settlement with 1 foot - 6 inch minimum length required.
3. The size of the joint bonding conductor shall be as indicated in the following table:

	PRESSURE CLASS				
Pipe Size	150	200	250	300	350
3 inch	N/A	N/A	N/A	N/A	1 - #8
4 inch	N/A	N/A	N/A	N/A	1 - #8
6 inch	N/A	N/A	N/A	N/A	1 - #8
8 inch	N/A	N/A	N/A	N/A	1 - #6
10 inch	N/A	N/A	N/A	N/A	1 - #6
12 inch	N/A	N/A	N/A	N/A	1 - #4
14 inch	N/A	N/A	1-#4	1-#4	1 - #4
16 inch	N/A	N/A	1-#2	1-#2	1 - #2
18 inch	N/A	N/A	1-#2	1-#2	1 - #2
20 inch	N/A	N/A	1-#2	1-#2	1 - #0
24 inch	N/A	1-#0	1-#0	1-#0	1 - #0
30 inch	1-#0	1-#0	1-#00	1-#00	1 -#00
36 inch	1-#00	2-#0	2-#0	2-#0	2 - #0
42 inch	2-#0	2-#0	2-#0	2-#00	2 -#00

C. Installation Procedure

1. Thoroughly prepare the location on the pipe that is to receive the weld. This is usually achieved by first removing the outside coating and then grinding the area to bright metal with an abrasive wheel grinder.
2. Position the conductor and mold at the weld location.
3. Insert metal disk in mold and pour in weld charge.
4. Ignite charge with flint gun.
5. Inspect and clean weld connection.
6. After the joint bond is completed, protect the connection and bright metal exposed with epoxy.

3.5 POLYETHYLENE ENCASEMENT INSTALLATION

A. Polyethylene wrap shall be sealed using heavy duty duct type tape or other method recommended by the manufacturer to create a watertight encasement of the ductile iron pipe.

B. To prevent the polyethylene wrap from being torn or otherwise damaged by backfill material the polyethylene wrapped pipe shall be first backfilled with sand to a depth of at least 6 inches below the bottom, around the sides, and over the top of the pipe.

END OF SECTION 33 11 14

SECTION 33 11 16 - METAL PIPE AND FITTINGS FOR WATER UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for Metal pipe and fittings including the following:

1. Ductile Iron pipe and fittings.
2. Copper pipe and fittings.
3. Stainless steel pipe.
4. Stainless steel tubing.
5. Steel pipe.
6. Mechanical couplings.
7. Gripper glands.
8. Polyethylene encasement.
9. Piping specialties.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.4 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall provide the proper equipment, tools and facilities necessary for the efficient prosecution of the work.

1. Materials damaged in unloading, handling or installation shall be promptly discarded and removed from the area of the work.
2. No pipe shall be unloaded or moved by allowing the pipe to roll, slide or fall to the ground or to cushions placed on the ground.
3. No pipe, fittings, valves, etc., shall be unloaded by inserting loader blades, teeth, etc., into the pipe interior.

B. Pipe shall be stored on racks or timbers in such a manner that pipe ends are above the ground surface.

1. When pipe is to be moved it shall not be dragged or rolled but shall be lifted by use of a sling designed to prevent damage to the pipe coatings.
2. Should an intermediate placement of the pipe along the side of the trench be required, the pipe shall be placed on racks or timbers along the side of the trench in manner as specified hereinabove.

C. Each length or section of pipe shall be cleaned immediately before being placed in the trench and joined.

1. Cleaning shall be accomplished by use of a tight swab or other suitable cleaning device.
2. If necessary, a brush pig shall be run through the section of pipe prior to final swabbing.
3. Pipe ends shall be wiped clean before the pipe is joined.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ductile Iron Pipe:

1. American
2. U.S. Pipe and Foundry Company
3. McWane

B. Ductile Iron Fittings:

1. American
2. U.S. Pipe and Foundry Company
3. McWane
4. Tyler

C. Restraining Gaskets:

1. Field-lok gaskets as manufactured by U.S. Pipe and Foundry Company
2. Fast-grip gaskets as manufactured by American Cast Iron Pipe Company
3. Approved Equivalent.

D. Gripper (Restraining) Glands

1. "MJ gripper gland" manufactured by U.S. Pipe and Foundry Company
2. "MegaLug" manufactured by Ebaa Iron, Inc.
3. Approved Equivalent

E. Fittings for Copper Water Tube

1. Mueller
2. Hays

3. Ford Meter Box Company
4. Swagelok (up through 1" size)
5. Crane
6. Imperial
7. Approved Equivalent

F. Mechanical Couplings

1. Smith Blair
2. Dresser
3. Dependo-Lok
4. Approved Equivalent

2.2 PIPE MATERIALS AND FITTINGS

A. The Contractor shall carefully examine all pipe and piping materials before placing them in the work.

1. If any such pipe or materials should be found to be defective, the Contractor shall promptly notify the Engineer and discard such pipe and materials.

B. The interior of all pipe, fittings, valves and accessories shall be kept free from dirt and foreign material.

1. Suitable bulkheads shall be used to block or plug ends of piping at the close of each work day and when work on a particular section of piping is temporarily discontinued.
2. Should dirt, mud, concrete, laitance, paint or other foreign materials be allowed to enter the piping or any section of piping, such piping or section of piping shall immediately be cleaned.

C. Piping materials shall be of the types, classes and sizes as shown or as specified in the piping schedule.

2.3 DUCTILE IRON PIPE AND FITTINGS

A. Ductile Iron pipe shall be manufactured in accordance with requirements of ANSI A21.51 / AWWA C151.

B. Where ductile iron pipe and fittings are equipped with push-on joints, such joints shall conform to the requirements of ANSI A21.11 / AWWA C111 latest revision.

C. Where ductile iron pipe and fittings are equipped with mechanical joints, such joints shall conform to the requirements of ANSI A21.11 / AWWA C111 latest revision.

D. All pipe and fittings shall be furnished new from the manufacturer. No recoated or reconditioned pipe will be acceptable.

E. Gaskets

1. Gaskets for flanged, mechanical joint restrained joint, and push-on ductile iron pipe shall meet the requirements of ANSI/AWWA Specification ANSI A21.11/AWWA C111 latest revision.
2. Gasket materials for various service conditions shall be as follows:

    a. Air and Water service (up to 120^{o}F) - Synthetic Rubber
    b. Air and Water service (120^{o}F to 200^{o}F) - Neoprene

F. Pipe

1. In general, ductile iron pipe shall be furnished with push-on joints for buried applications and flanged joints for exposed, above grade applications, unless otherwise shown on Drawings.
2. Ductile iron flanged pipe shall conform to the following requirements:

    a. Shall be manufactured in accordance with the requirements of ANSI A21.15 AWWA C115 latest revision.
    b. Barrels of flanged pipe shall be ductile iron ANSI A21.51/AWWA C151.
    c. Flanges shall be in accordance with ANSI A21.15/AWWA C115 latest revision, and shall have chemical and physical properties specified for ductile-iron fittings under ANSI A21.10/AWWA C110 latest revision.
    d. Pipe and threaded flanges shall meet the requirements of ANSI A21.15 /AWWA C150, latest revision.
    e. Where flanges are cast on ductile-iron pipe they shall conform to ANSI A21.10/AWWA C110 latest revision and shall be ductile-iron as specified for threaded flanges.
    f. All flanges shall be rated for 250 psi working pressure; and the bolt circle and bolt holes shall match those of ANSI B16.1 Class 125 flanges and ANSI B16.5 Class 150 flanges.
    g. Flanged piping connecting to equipment shall have flanges that are compatible with the particular items of equipment to which they are attached.

G. Fittings

1. In general, fittings for use with push-on joint pipe shall be push-on joint unless otherwise shown on the Drawings.
2. Flanged fittings shall have flanges suitable for use with the type of flanged pipe and equipment to which they are connected, and flanges shall meet the requirements stated hereinabove for ductile iron pipe flanges.

    a. Fittings for use with flanged pipe shall conform to the requirements of ANSI A21.10 / AWWA C110 and shall have chemical and physical properties specified for ductile iron under ANSI A21.10 / AWWA C110.
    b. All flanges shall be rated for 250 psi working pressures; and the bolt circle and bolt holes shall match those of ANSI B16.1 Class 125 flanges and ANSI B16.5 Class 150 flanges.

3. All fittings shall be new. No reconditioned or recoated fittings shall be acceptable.
4. The Contractor may elect to use grooved end joints conforming to ANSI A21.10/AWWA C606 in lieu of flanged joints. The Contractor shall be responsible

for making all revisions necessary for a complete installation which is similar in function to a flanged piping system.

5. Couplings for use with grooved end joints shall be ductile iron in accordance with ASTM 536, Grade 65-45-12.

    a. Gaskets shall be the center leg design manufactured of a nitrile compound.
    b. Bolts shall be track head design and manufactured in accordance with ASTM A-183, minimum tensile 110,000 psi.
    c. Couplings shall be Victaulic, or equivalent.

6. Bolting shall conform to Table 10.14 of ANSI A21.10 / AWWA C110 or ANSI A21.15 / AWWA C115 as applicable.

    a. Bolts for use with flat ring type gaskets between gray iron flanges shall conform to the requirements of ASTM A 307-84, Grade B, hex head; and nuts shall be hex type of same grade and finish as the bolts.
    b. Bolts for use with flat full-face type gaskets between either gray iron flanges or ductile iron flanges shall conform to the requirements of ASTM A449-84a, Type 1 hex head; and nuts shall be hex type of same grade and finish as the bolts.
    c. Bolts shall conform to the requirements of ANSI B18.2.1, and nuts shall conform to the requirements of ANSI B18.2.2.

7. Wall pipes shall either be statically cast or fabricated from centrifugally cast ductile iron pipe.
8. Flanges shall be provided in between the ends of the wall pipe to serve as a thrust collar and/or water stop, as required.
9. For fabricated wall pipes, the space between the thrust collar or water stop shall be sealed by full welding on each side.
10. Gaskets for flanged joints shall be of materials as specified herein for various service conditions.

    a. Gaskets shall be 1/8" thick, unless otherwise specified and/or indicated for special conditions, and shall conform to dimensions as given in Table A.1 of Appendix A to ANSI A21.15 / AWWA C115 or Table A.1 of Appendix A to ANSI A21.10 / AWWA C110 latest revision or as applicable.
    b. Gaskets shall be flat ring type and flat full-face type according to service conditions.
    c. Flat ring type shall not be used where working pressures exceed 50 psi.

11. Fittings for use with push-on or mechanical joint pipe shall be compact or full bodies, and shall conform to the requirements of ANSI A21.10/AWWA C110, latest revision or ANSI A21.53/AWWA C153, latest revision.
12. Fittings meeting the requirements of C110 may be either gray iron or ductile iron where working pressures are less than 250 psi; where working pressures exceed 250 psi, fittings shall be ductile iron.
13. Fittings meeting the requirements of C153 shall be ductile iron in all situations.

H. Coatings

1. All ductile iron pipe and fittings shall be furnished with interior lining.

2. The types of lining required for the various conditions of service are listed hereinbelow.

    a. Water service (up to 140° F) - Cement lining in accordance with ANSI A21.4 / AWWA C104 latest revision; standard thickness, with asphaltic seal coat.
    b. Water service (140°F - 225°F) - High-heat resisting epoxy enamel, (without cement undercoat), T&O free and FDA approved, specially formulated for hot water service, and applied to total dry film thickness of not less than 15 mils.
    c. Air Service - Unlined, or approved lining recommended by manufacturer.

3. Cement lining for pipe intended for water service shall be certified for use with potable water.

    a. Cement lining applied to ductile iron pipe intended for hot water service (above 150°F) shall have enamel overcoat of epoxy approved for hot water service at the particular application

4. Ductile iron pipe for air service shall be furnished with coal tar epoxy lining (16 mils dry film thickness) suitable for temperatures up to 250°F, or other equivalent lining as recommended by pipe manufacturer.
5. All ductile iron pipe and fittings, including pipe and fittings to be submerged in liquids, shall be tar-coated outside except when installed in particular locations as hereinafter specified:

    a. Ductile iron pipe installed in buildings, galleries, vaults or other similar structures or locations where the piping is to be permanently exposed and specified to be painted, shall be furnished with exterior coat of rust-inhibitive primer suitable for application of finish coating as specified in these Specifications.
    b. Ductile iron or gray iron wall-pipes, wall-sleeves or other wall-fittings, and fittings to be encased in concrete, shall be furnished "bare" (without tar-coat).
    c. Ductile iron pipe, where passing through concrete walls, shall have exterior tar-coat removed from that length of the pipe to be encased in the wall.
6. Ductile iron pipe to be installed underground shall be furnished with outside asphaltic coating of 1 mil thickness per ANSI A21.51 / AWWA C151.

I. Quality Control

1. All testing work specified in this section shall be performed by the supplier.
2. The manufacturer shall perform all tests in house as part of their quality assurance/quality control.
3. Test results shall be submitted to the Engineer in accordance with requirements of this section.
4. All pipe shall receive a hydrostatic proof test of 500 psi for a minimum duration of 10 seconds.

    a. Each test cycle shall be recorded on a strip chart.
    b. Each test cycle for pipe 18 inches and greater shall be marked by pipe number.

c. Each pipe shall be inspected for leaks and pipes which contain evidence of hydrostatic leak shall be scrapped.
d. Repair welding of hydrostatic leaks is not permitted.

5. Tensile test specimens shall be cut from the midsection of the pipe wall.

   a. These specimens shall be machined and tested at least every three hours in accordance with ASTM E-8, and ASTM A-370 where applicable, using the halt of pointer or 0.2% offset method.
   b. Pipe failing to meet the minimum requirements of these standards shall be rejected.
   c. Adjacent test samples shall be made available to the Owner's independent testing laboratory upon the Owner's request.

6. Charpy impact samples shall be taken during each hour of production. Samples shall be selected to properly represent extremes of pipe diameters and wall thickness.

7. Impact tests shall be conducted in accordance with ASTM E-23.

   a. Impact strengths on samples shall be 7 ft.-lb minimum for tests conducted at $70^{o}\pm10$.
   b. In addition, adjacent specimens shall be taken and made available to the Owner's laboratory for independent testing upon the Owner's request.

8. Each end of each pipe (each pipe socket and pipe spigot) shall be measured and shall conform to the standard dimensions of ANSI A-21.51 (AWWA C-151).

   a. In addition, each socket and spigot shall be inspected in a well-lighted area for injurious defects which could affect joint performance.
   b. Such defects may be removed by cutting off pipe ends.
   c. Pipe with injurious defects in the bell must be scrapped.

9. The Owner or his designated inspection agency shall have access to all areas of the pipe manufacturer's plant during production, inspection, and shipping and shall have the opportunity to witness all tests associated with production and inspection of pipe and fittings for any given pipe order. Reasonable facilities shall be provided for this purpose.

10. The Contractor shall provide manufacturers' certifications that all ductile iron pipe and fittings meet provisions of this section and meet requirements of ANSI A21.51 (AWWA C-151).

    a. Product certification shall include tensile and Charpy test results which shall be traceable to pipe numbers and testing periods.
    b. For pipe sizes 18 inches and greater, hydrostatic test charts including pipe numbers for each test cycle shall be furnished as part of the certification test reports.
    c. Chemical analysis shall be furnished for each ladle of iron which will cover each pipe cast and must correlate with the mechanical test results.
    d. For pipe sizes 18 inches and greater, complete traceability is required

throughout the certification process and must be clearly legible on each pipe at the point of installation.

11. The Contractor shall provide certifications that all pipe joints have been tested and meet requirements of ANSI A21.11 (AWWA C-151).

J. Restrained Joint Pipe.

1. The following types of restrained joint pipe will be acceptable:

a. Flexible, restrained push-on type where joints incorporate ductile iron locking segments, inserted through slots in the bell face, providing a positive axial lock between the bell interior surface and a retainer weldment on the spigot end of the pipe.
b. Restraining gaskets for push-on pipe and fittings 4" through 12" diameter. Restraining gaskets shall contain stainless steel locking segments vulcanized into the gasket which shall in all other respects meet the requirements of standard push-on gaskets in ANSI/AWWA C111/A21.11. Restraining gaskets shall be UL listed for a minimum working pressure of 250 psi.
c. Gripper glands may be used with mechanical joint fittings. Joint restraint shall be provided by a follower gland with mechanism that grips pipe with teeth which are wedged tighter as pressure is applied to the pipeline. Gripper glands shall have a working pressure rating of at least 350 psi up to 16" size and at least 250 psi up to 48" size. Gland shall conform to mechanical joint (ANSI/AWWA a21.11) and be suitable for use with tee-head bolts (ANSI/AWWA c153/a21.5).

2. Maximum allowable deflections shall be per manufacturer's publish recommendation.
3. Use of set screws bearing on the pipe wall will not be acceptable except where retainer glands are to be used.

K. Markings

1. Each length or piece of pipe shall be bar coded and clearly marked as to type and class with different colors being used to distinguish between classes.
2. Where the drawings indicate that between specified stations a particular class of pipe will be required, the Contractor will not be permitted to store or string pipe of other classes than that specified for the particular section of the transmission mains.

2.4 COPPER PIPE AND FITTINGS

A. Copper pipe shall be seamless copper water tube meeting the requirements of AWWA Specification 7S-CR, latest revision Type K for copper water tube, or of ASTM Specification ANSI/ASTM B88, latest revision Type K for copper water tube.

B. Water tube may be furnished in drawn temper (H) or annealed (O), according to location, service conditions and sizes as hereinafter described.

C. Class O tube may be used underground in sizes through 1¼".

1. Class O tube is suitable for use with flared or compression fittings, and with solder-type fittings, provided that rounding, sizing, and preparation of tube ends is performed with the proper tools.
2. Copper water tube installed underground in sizes 1½" and larger shall be Class H, furnished in straight lengths. Fittings shall be solder-type.
3. All branches from underground tube (1½" and larger) shall be made by use of brass unions and copper to L.P.S. adapters.
4. All valves installed at tees and/or crosses in piping runs shall be similarly equipped.

D. Copper water tube installed in buildings, vaults, galleries, etc., shall be Class H, furnished in straight lengths, and shall be installed in straight runs.

1. An exception to the specification relative to installation of copper water tube in straight runs may be made when short lengths (not greater than 4') of tubing requiring bends and/or offsets are necessary for connection of items of equipment to water supply lines.
2. This exception would apply only to tubing sizes 3/8" and smaller.

E. Fittings for tube of sizes 1¼" and larger shall be solder-joint type except that all branches from the main run (whether from tees or crosses) shall be equipped with brass unions and copper to I.P.S. adapters.

F. Valves are required on all branches, and all valves are required to be equipped with brass unions and copper to I.P.S. adapters.

2.5 STAINLESS STEEL PIPE

A. Stainless steel pipe shall conform to the requirements of ANSI/ASTM A778, latest revision, Grade TP 304.

B. Stainless steel pipe shall be furnished in accordance with nominal pipe sizes and nominal wall thicknesses given in Table 1 of the American National Standard for Stainless Steel Pipe (ANSI B36.19, latest revision).

C. Pipe sizes and Schedules (nominal wall thicknesses) shall be as indicated, but in no case shall they be less than Schedule 10. Flanges, nuts and bolts shall also be made of stainless steel unless otherwise specifically shown on Drawings.

D. All fittings shall be forged fittings unless otherwise specifically shown on the Drawings.

E. Flanged pipe ends shall be made of type 304L stainless steel slip-on type rolled angel face rings and stainless steel back-up flanges drilled to ANSI 16.1 class 125 standard. The angle face ring thickness shall be continuously welded on both sides to the pipe or fitting. The angle leg shall not interfere with the flange bolt holes.

2.6 STAINLESS STEEL TUBING

A. Stainless steel tubing shall conform to the requirements of ANSI/ASTM A269, latest revision, Grade TP 304 or Grade TP 316.

B. Each length of tube shall be tested by the manufacturer in accordance with ANSI/ASTM A450, latest revision.

2.7 STEEL PIPE

A. Steel pipe shall conform to the requirements of ASTM Specification Designation A 53, for black and hot-dipped galvanized seamless steel pipe, 'standard weight.'

B. Pipe for use in buildings shall be furnished with threaded ends for use with threaded malleable iron fittings (black) and unions.

C. Pipe installed underground shall have welded joints and shall be equipped with protective covering mechanically applied in a factory or, where approved by the Engineer, in a field plant especially equipped for pipe coating application.

D. Specials and fittings which cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant applying the protective covering to the pipe.

E. Joints shall be coated and wrapped by hand after welding has been completed, welds inspected, and pipe tested.

F. All hand coating and wrapping shall be done in a manner and with materials that will produce a covering equal in effectiveness to that of the mechanically applied covering.

G. The pipe covering shall consist of coal-tar priming coat, coat of coal tar enamel, wrapper of felt, and a wrapper of kraft paper or coat of water resistant white paint (wash).

H. The coatings and wrappings shall be applied in the order named hereinabove, and all materials and procedure shall conform to the requirements of AWWA Specification C204, except that interior lining will not be required.

I. Where steel pipe is specified to be furnished galvanized the protective covering will not be required.

2.8 MECHANICAL COUPLINGS

A. Pipe couplings shall be threaded, push-on mechanical joint, or bolted as specified herein or as indicated.

B. Harness bolts, where required on lines under pressure where shown shall be one of the following:

1. Joint restraint system as manufactured by Star National Products.
2. Standard system of the pipe manufacturer.
3. Approved equivalent.

C. Mechanical couplings shall be carefully installed in accordance with the manufacturer's recommendations.

1. A space of at least ¼ inch and not more than one inch shall be left between the pipe ends.
2. Pipe and coupling surfaces which contact gaskets shall be clean and free from dirt and other foreign matter during assembly.
3. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks and all parts of the coupling are square and symmetrical with the pipe.
4. Following installation of the coupling, damage areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of the Engineer.
5. The interior surfaces of the middle rings shall be prepared for painting in accordance with instructions of the paint manufacturer and shall then be coated with liquid epoxy in accordance with AWWA C210.
6. The remaining components shall be cleaned and shop primed with the manufacturer's standard rust-inhibitive primer.

2.9 GRIPPER GLANDS

A. Where gripper glands are indicated for use with mechanical joint fittings, joint restraint shall be provided by a follower gland with a mechanism that grips the pipe with teeth which are wedged tighter as pressure is applied to the pipeline.

B. Gripper gland shall have a working pressure rating of at least 350 psi up to 16" size and at least 250 psi up to 48" size.

C. Gland shall conform to mechanical joint (ANSI/AWWA A21.11) and be suitable for use with tee-head bolts (ANSI/AWWA C153/A21.53).

D. Gripper gland shall be one of the following:

1. "MJ Gripper Gland" manufactured by U.S. Pipe and Foundry Company.
2. "Mega Lug" manufactured by EBAA Iron, Inc.
3. Approved equivalent.

2.10 POLYETHYLENE ENCASEMENT.

A. Polyethylene plastic wrap manufactured for the protection of ductile iron pipe.

B. The polyethylene wrap shall have a minimum thickness of 8 mils (0.008 in.).

C. The wrap shall meet the requirements of AWWA C105 and shall be constructed from virgin polyethylene material conforming to the requirements of ANSI/ASTM Specification D1248.

D. Polyethylene wrap shall be sealed using heavy duty duct type tape or other method recommended by the manufacturer to create a watertight encasement of the ductile iron pipe.

1. To prevent the polyethylene wrap from being torn or otherwise damaged by backfill material the polyethylene wrapped pipe shall be first backfilled with sand to a depth of at least 6 inches below the bottom, around the sides, and over the top of the pipe.

2.11 PIPING SPECIALTIES

A. Flexible Connectors for Nonferrous-Metal Piping shall conform to the following requirements:

1. Shall have a bronze hose covered with bronze wire braid.
2. Shall have a copper-tube.
3. Shall be pressure-type.
4. Shall have solder-joint ends or bronze flanged ends brazed to hose.

B. Flexible Connectors for Ferrous Piping shall conform to the following requirements:

1. Shall have s stainless-steel hose covered with stainless-steel wire braid with one of the following welded to the hose:

    a. Threaded steel pipe nipples conforming to ASME B1.20.1.
    b. Steel pipe flanges conforming to ASME B16.5.

C. Dielectric Fittings shall conform to the following requirements:

1. Shall be a combination of copper alloy and ferrous.
2. Shall be threaded, solder, or plain end types.
3. Shall have matching piping system materials.

D. Dielectric Unions shall conform to the following requirements:

1. Shall be factory-fabricated union assembly, designed for 250-psig minimum working pressure at 180 deg F.
2. Shall include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.

E. Dielectric Flanges shall conform to the following requirements:

1. Shall be factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure to suit system pressures.

F. Dielectric-Flange Insulation Kits shall conform to the following requirements:

1. Shall have a field-assembled companion-flange assembly.
2. Shall be full-face or ring type.
3. Components include the following:

    a. Neoprene or phenolic gasket.
    b. Phenolic or polyethylene bolt sleeves.
    c. Phenolic washers.
    d. Steel backing washers.

4. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.

G. Dielectric Couplings shall conform to the following requirements:

1. Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples shall conform to the following requirements:

1. Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig minimum working pressure at 225 deg F.

2.12 JOINING MATERIALS

A. Transition Couplings for Underground Piping, NPS 1-1/2 and Smaller:

1. Shall be manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Transition Couplings for Underground Piping, NPS 2 and Larger:

1. Shall conform to AWWA C219.
2. Shall be metal, sleeve-type coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Transition Couplings for Aboveground or Vault Piping:

1. Pipe fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

D. Brazing Filler Metals:

1. Shall be AWS A5.8, BCuP Series.

E. Soldering Flux:

1. Shall conform to ASTM B 813.
2. Shall be water-flushable type.

F. Solder Filler Metal
1. Shall conform to ASTM B 32.
2. Shall be lead-free type with 0.20 percent maximum lead content.

G. Plastic Pipe-Flange Gasket, Bolts, and Nuts:

1. Shall be the type and material recommended by piping system manufacturer, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTILE IRON PIPE

A. The Contractor will not be permitted to cut nipples from ungauged pipe in order to make connections.

1. If the Contractor desires to cut lengths in the field to make up the line, he shall make such cuts from lengths of pipe having exterior of barrel fully gauged to fit bell of pipe of that class.

B. The permissible depth of cover over a pipe of particular size and class is based upon the following:

1. The trench excavation work being performed by the Contractor in accordance with the requirements of these Specifications.
2. The bedding and backfill materials being furnished by the Contractor in accordance with the requirements of these Specifications.
3. The placement of bedding and backfill material being performed by the Contractor in accordance with the requirements of these Specifications.

C. Should the Contractor fail to perform the trench excavation work, or the furnishing and placement of bedding and backfill, or the pipelaying work in accordance with the requirements of these Specifications, he/she will be required to remedy the work by furnishing and placing or installing other materials as may be determined by the Engineer as being necessary to remedy that work not performed in accordance with these Specifications and thereby secure work of the quality specified.

D. Buried ductile iron pipe for all applications shall be furnished and installed in trenches in various locations along the pipeline(s) as indicated and described herein. Pipe thickness and/or class shall meet requirements and recommendations of the manufacturer and ANSI/AWWA C151/A21.51 for depth of cover, working pressure and laying conditions when classes of pipe and depths of cut are not indicated elsewhere.

SCHEDULE OF REQUIRED WALL THICKNESSES FOR PRESSURE PIPING DUCTILE IRON PIPE ANSI A21.51, GRADE 60-42-10	
Pipe Size (Inches)	Cover not Exceeding 16' Wall Thickness
4	0.29"
6	0.31"
8	0.33"
10	0.35"
12	0.37"
14	0.39"
16	0.40"
18	0.41"
20	0.42"
24	0.44"

30	0.47"
36	0.53"
42	0.59"
48	0.65"
54	0.73"

3.2 JOINING OF PIPE

A. Pipe joining procedure shall be in accordance with these Specifications and in accordance with the recommendations of the manufacturer of the particular type of joint.

B. Ductile Iron Pipe

1. Mechanical Joint Pipe

a. The joining of mechanical joint pipe shall be performed in accordance with AWWA standard for installation of Cast Iron Water Mains C600.
b. The ends of the two pieces of pipe to be joined shall first be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter, and then lubricated prior to joining glands shall be slipped on the spigot end of the pipe with the lip extension of the gland toward the socket end.
c. The rubber gasket shall be lubricated and placed on the spigot end with the thick edge toward the gland.
d. The entire section of the pipe shall be pushed forward to seat the spigot end in the bell.
e. The gasket shall then be pressed in place within the bell, care being taken to locate the gasket evenly around the entire joint.
f. The cast iron gland shall be moved along the pipe into position for bolting; all the bolts shall be inserted, and hard tightened.
g. All nuts shall then be tightened with a suitable torque-limiting wrench.
h. The torque for various sizes of bolts shall be per the manufacturer's recommendations.
i. Nuts spaced 100 to 180 degrees apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland.

2. Push-On Joint Pipe

a. The joining of Push-on joint pipe shall be performed in accordance with the AWWA Standard for Installation of Cast Iron Water Mains C600 and in accordance with the manufacturer's instructions and/or recommendations for the particular joint furnished.
b. The inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating and other foreign matter.
c. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the socket.

d. A thin coat of gasket lubricant shall be applied to either the inside surface of the gasket or outside surface of the spigot, or both.
e. Gasket lubricant shall be as supplied by the particular manufacturer and reviewed by the Engineer.
f. The spigot end of the pipe shall be carefully inserted in the socket so that the joining surfaces will not come in contact with the ground, trench bed or trench sides.
g. The joint shall then be completed by forcing the spigot end to the bottom of socket by methods as recommended by the particular manufacturer and concurred with by the Engineer.
h. All pipe shall be furnished with a depth mark to indicate a 'full-home' assembly.
i. The Contractor shall provide special transition sleeves or transition pieces of pipe for connecting pipe of different classes; and those special pieces shall be clearly identified with suitable marking.
j. If the Contractor desires to cut lengths in the field to make closures, he shall have on hand an adequate number of lengths of pipe of the various classes having the exterior of the barrel gauged to fit the socket of pipe.

3. Restrained Joint Pipe

a. Joints and pipe ends for restrained joint pipe shall be prepared and installed in accordance with the pipe manufacturer's recommendations.

4. Flanged Pipe

a. The joining of flanged ductile iron pipe shall be in accordance with the requirements of ANSI B31.1.0.
b. All bolt holes shall so match as to permit free insertion of bolts without binding.
c. Faces of flanges shall match fully and shall be true both horizontally and vertically before the bolts are tightened.
d. Any misalignment or vertical deviation from a true match shall not be corrected by tightening the bolts but shall be remedied by adjustment of the piping.
e. The same requirements shall apply for connection of flanged pipe to flanged equipment.
f. Gaskets shall be suitable for the particular class of flanges with which the pipe is equipped, and the entire piping system shall be leak-proof.

3.3 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. Ductile-Iron Sewer Pipe with Ductile-Iron Fittings: According to AWWA C600.

C. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.4 POLYETHYLENE ENCASEMENT INSTALLATION

A. Polyethylene wrap shall be sealed using heavy duty duct type tape or other method recommended by the manufacturer to create a watertight encasement of the ductile iron pipe.

B. To prevent the polyethylene wrap from being torn or otherwise damaged by backfill material the polyethylene wrapped pipe shall be first backfilled with sand to a depth of at least 6 inches below the bottom, around the sides, and over the top of the pipe.

END OF SECTION 33 11 16

SECTION 33 11 18 - PLASTIC PIPE AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for Plastic pipe and fittings including the following:

1. Plastic pipe and fittings
2. Fiberglass pipe and fittings
3. Cleanouts

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.4 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall provide the proper equipment, tools and facilities necessary for the efficient prosecution of the work.

1. Materials damaged in unloading, handling or installation shall be promptly discarded and removed from the area of the work.
2. No pipe shall be unloaded or moved by allowing the pipe to roll, slide or fall to the ground or to cushions placed on the ground.
3. No pipe, fittings, valves, etc., shall be unloaded by inserting loader blades, teeth, etc., into the pipe interior.

B. Pipe shall be stored on racks or timbers in such a manner that pipe ends are above the ground surface.

1. When pipe is to be moved it shall not be dragged or rolled but shall be lifted by use of a sling designed to prevent damage to the pipe coatings.

2. Should an intermediate placement of the pipe along the side of the trench be required, the pipe shall be placed on racks or timbers along the side of the trench in manner as specified hereinabove.

C. Each length or section of pipe shall be cleaned immediately before being placed in the trench and joined.

1. Cleaning shall be accomplished by use of a tight swab or other suitable cleaning device.
2. If necessary, a brush pig shall be run through the section of pipe prior to final swabbing.
3. Pipe ends shall be wiped clean before the pipe is joined.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL AND FITTINGS

A. The contractor shall carefully examine all pipe and piping materials before placing them in the work. If any such pipe or materials should be found to be defective, the Contractor shall promptly notify the Engineer and discard such pipe and materials.

B. The interior of all pipe, fittings, valves and accessories shall be kept free from dirt and foreign material.

1. Suitable bulkheads shall be used to block or plug ends of piping at the close of each work day and when work on a particular section of piping is temporarily discontinued.
2. Should dirt, mud, concrete, latence, paint or other foreign materials be allowed to enter the piping or any section of piping, such piping or section of piping shall immediately be cleaned.

C. Piping materials shall be of the types, classes and sizes shown or as specified in the piping schedule.

2.2 PLASTIC PIPE AND FITTINGS

A. General Service

1. Plastic pipe shall be of types as hereinafter specified or as shown on the Drawings.
2. The particular Type, Grade and Schedule of pipe used for a particular installation shall be suitable for the service intended.
3. PVC pipe shall be manufactured from rigid polyvinylchloride compounds meeting the requirements of ASTM D1784, latest revision, Class 12454-B.
4. Pipe shall meet requirements of ASTM D1785 latest revision Type 1.
5. Pipe shall be Schedule 80 unless otherwise indicated, and shall be furnished with threaded ends suitable for connection to fittings, companion flanges, and flanged valves.
6. Fittings shall meet the requirements of ASTM D2464, latest revision.
7. All pipe, fittings and valves shall be manufactured from molding compounds meeting the requirements of ASTM D1784, latest revision, Class 12454-B as specified hereinabove so as to ensure compatibility of materials.

8. Materials from which pipe, fittings and valves are manufactured shall have been tested and approved by the National Sanitation Foundation and shall be suitable for service associated with the production of potable water.
9. PVDF pipe shall be manufactured from natural polyvinylidene fluoride compound meeting the requirements of ASTM D3222, latest revision, and having a minimum tensile strength of 7100 psi at 73^{o}F when tested in accordance with ASTM D638, latest revision.
10. Pipe shall have nominal pipe sizes and wall thicknesses as given for Schedule 80 pipe in Table 2 of ASTM D1785, latest revision, unless otherwise indicated.
11. Fittings may be either socket fusion type meeting the requirements of ASTM D2657, latest revision, or threaded type having dimensions and tolerances in accordance with ASTM D2464, latest revision, according to the manufacturer's recommendations.
12. If the socket fusion type method of joining the pipe should be used, disassembly of pipe shall be provided for at changes of direction of pipe and at valves by use of companion flanges or threaded couplings or other means as recommended by the manufacturer.
13. All pipe, fittings and valves shall be manufactured from molding compounds meeting the requirements of ASTM D3222, latest revision, as specified hereinabove so as to ensure compatibility of materials, and all materials (including joining materials) shall be suitable for service associated with the production of potable water.
14. Magnetic locator tape shall be provided for all plastic piping installed underground.

B. Gravity Sewer Service

1. PVC gravity sewer pipe shall conform in all respects to Standard Specifications for Type PSM Polyvinylchloride (PVC) Sewer Pipe and Fittings ASTM D 3034, latest revision, (sizes 4" - 15"); ASTM F679, latest revision, (sizes 18" - 27"); covering requirements and test methods for materials, dimensions, workmanship, flattening resistance, impact resistance, pipe stiffness, extrusion quality, joining systems and a form of marking.
2. Pipe conforming to ASTM D3034, latest revision, shall have a minimum wall thickness of SDR 35.
3. Pipe conforming to ASTM F679, latest revision, shall have a minimum pipe stiffness (PS) of 46 psi and minimum T-1 wall.
4. Pipe shall be furnished in sections not less than ten (10) feet in length and not greater than thirteen (13) feet in length.
5. Pipe and fittings shall be inspected and tested in accordance with ASTM D 3034 or ASTM F679, latest revisions, by a testing laboratory acceptable to the Owner and certified copies of the test reports and test results shall be furnished to the Owner.
6. Pipe and fittings shall be clearly marked in accordance with Section 12 of ASTM D 3034, or Section 11 of ASTM F679.
7. Pipe shall be furnished with bell and spigot end with elastomeric seals.
8. Spigot (plain) ends shall be marked to indicate when a "full-home" position of spigot in bell has been attained.
9. Seal rings or gaskets shall be continuous elastomeric rings meeting the requirements of ASTM D 3212, latest revision.
10. Material for seal ring shall be specifically formulated for wastewater service.

11. The joints shall meet all test requirements of ASTM D 3212, latest revision, and certificates of compliance shall be furnished to the Owner.

C. Water Line Service

1. Polyvinylchloride (PVC) water pipe, 4 inch to 12 inch diameter, shall be AWWA C-900 Class 150 (DR-18) and shall bear the seal NSF. Joints shall conform to ASTM D3139 or ASTM D3212.
2. PVC pipe less than 4-inches in diameter shall be Schedule 80 with a pressure rating of 200 psi solvent welded, including blow-off assemblies.
3. PVC pipe shall meet the requirements of AWWA C900, Class 200 (SDR 14, minimum) with the same outside diameters for corresponding nominal sizes of ductile iron pipe meeting the requirements of AWWA C151.
4. PVC pipe shall be capable of making connection with cast iron fittings meeting the requirements of AWWA C111 without the use of adaptors.
5. Pipe shall be fabricated in nominal 20 foot lengths.
6. PVC pipe shall be equipped with bell and spigot joints.
7. Bell shall consist of integral wall section with pipe.
8. Bell section shall have same hydrostatic strength as pipe wall and meet the requirements of AWWA C900.
9. Joints shall have elastomeric gaskets manufactured in conformance with ASTM F477.
10. Gaskets shall be formulated for water service and be supplied separately from the pipe bell with lubricant recommended by the pipe manufacturer.

D. Natural Gas Service

1. Polyethylene (PE) natural gas pipe and fittings shall be PE 2406 medium density polyethylene (MDPE) meeting cell classification 234363E per ASTM D3350. All pipe and fittings materials shall be opaque yellow in color. Materials shall be stabilized against ultraviolet deterioration and shall be suitable for unprotected outdoor storage for at least four (4) years.
2. Fittings shall be of the same diameter, type, and wall thickness of the pipeline being constructed. Fittings shall be manufactured and tested in accordance with ASTM D 2513 and applicable Federal Department of Transportation (DOT) regulations.

2.3 FIBERGLASS PIPE AND FITTINGS

A. RTRP (Fiberglass Pipe) shall conform to the following requirements:

1. AWWA C950.
2. Shall be [Class 150] [Class 200] [and] [Class 250].
3. Shall be Type I[or II].
4. Shall be [Grade 1, epoxy] [or] [Grade 2, polyester].
5. Shall have bell-and-spigot ends [for bonded] [with gasket or seal for gasketed] joints.
6. Liner is optional unless indicated.[Include FM approval if used for fire-service mains.]

B. RTRF (Fiberglass Fittings) shall conform to the following requirements:

1. AWWA C950
2. Shall be similar to pipe in material, pressure class, and joining method.

C. Fiberglass pipe (UL RTRP) shall conform to the following requirements:

1. UL 1713.
2. Shall be [Class 150] [and] [Class 200] [and] [Class 250].
3. Shall have bell-and-spigot ends with gasket or seal for gasketed joints
4. Liner is optional unless indicated.

D. Fittings shall be similar to pipe in material, pressure class, and joining method.

2.4 CLEANOUTS

A. PVC Cleanouts shall conform to the following requirements:

1. Shall have a PVC body with PVC threaded plug.
2. Shall include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping or proper adapters.

PART 3 - EXECUTION

3.1 JOINING OF PIPE

A. Pipe joining procedure shall be in accordance with these Specifications and in accordance with the recommendations of the manufacturer of the particular type of joint.

B. Push-On Joint Pipe

1. The joining of Push-On Joint pipe shall be performed in accordance with the AWWA Standard for Underground Installation of PVC Pressure Pipe and Fittings for Water, C606 and in accordance with the manufacturer's instructions and/or recommendations for the particular joint furnished.
2. The inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating and other foreign matter.
3. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the socket.
4. A thin coat of gasket lubricant shall be applied to either the inside surface of the gasket or outside surface of the spigot, or both.
5. Gasket lubricant shall be as supplied by the particular manufacturer and reviewed by the Engineer.
6. The spigot end of the pipe shall be carefully inserted in the socket so that the joining surfaces will not come in contact with the ground, trench bed or trench sides.
7. The joint shall then be completed by forcing the spigot end to the bottom of socket by methods as recommended by the particular manufacturer and concurred with by the Engineer.
8. All pipe shall be furnished with a depth mark to indicate a 'full-home' assembly.

9. The Contractor shall provide special transition sleeves or transition pieces of pipe for connecting pipe of different classes; and those special pieces shall be clearly identified with suitable marking.
10. If the Contractor desires to cut lengths in the field to make closures, he shall have on hand an adequate number of lengths of pipe of the various classes having the exterior of the barrel gauged to fit the socket of pipe.

C. Polyethylene Pipe

1. Heat Fusion Joining

a. Butt, socket, and saddle fusion joints in polyethylene gas pipe shall be made using procedures that have been qualified and approved by the Federal Department of Transportation (DOT) in accordance with CFR, Title 49, Part 192.283.
b. The Contractor shall ensure that all persons making heat fusion joints have been qualified to make joints in accordance the above referenced CFR code.
c. The contractor shall maintain records of qualified personnel and shall certify that qualified training was received not more than twelve (12) months prior to commencing work.

2. Butt Fusion of Unlike Wall Thicknesses

a. Butt fusion shall be performed between pipe ends, or pipe ends and fitting outlets that have the same outside diameter and are not different in wall thickness by more than one (1) standard DR (i.e. SDR 9 to SDR 11).
b. Transitions between unlike wall thicknesses greater than one (1) DR shall be made with a transition nipple or by mechanical means.

3. Mechanical Compression Couplings

a. Polyethylene gas pipe and fittings may be joined together to other materials by transition fittings or fully restrained mechanical couplings. These devices shall be designed for joining polyethylene gas piping to another material and shall be approved by the DOT.
b. When mechanical couplings are used for joining, polyethylene gas piping shall be reinforced with a stiffener in the pipe bore. Stiffeners shall be properly sized for the diameter and wall thickness of the polyethylene gas piping being joined.
c. For service connections, the stiffener length shall match the pipe end penetration depth into the coupling.

3.2 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. PVC Sewer Pipe and Fittings shall be as follows:

1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
2. Install according to ASTM D 2321.

3.3 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade.

1. Use PVC sewer pipe fittings in sewer pipes at branches for cleanouts and PVC sewer pipe for riser extensions to cleanouts.
2. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers located in unpaved areas in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding finished grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

END OF SECTION 33 11 18

SECTION 33 12 15 - HYDRAULIC GATES

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. This Section includes the following:

1. Slide Gates - The gates and appurtenances shall be supplied in accordance with the latest edition of AWWA C561 Standard for Fabricated Stainless Steel Slide Gates as modified herein. The allowable leakage rate for the stainless steel gates in this specification shall be 1/2 the allowable leakage listed in the latest revision of AWWA C561.

2. Weir Gates - The gates and appurtenances shall be supplied in accordance with the latest edition of AWWA C561 Standard for Fabricated Stainless Steel Slide Gates as modified herein. The allowable leakage rate for the stainless steel gates in this specification shall be 1/2 the allowable leakage listed in the latest revision of AWWA C561.

1.3 SUBMITTALS

A. Product Data:

1. Furnished specialties
2. Size
3. Accessories
4. Details of construction relative to materials
5. Dimensions of individual components
6. Profiles
7. Finishes.
8. Description of all materials.
9. Complete bill of materials.
10. Complete motor data (if applicable).
11. Structural design calculations.
12. Description of surface preparation, shop priming, and finish painting of gates.

B. Shop Drawings Showing:

1. Complete dimensional data.
2. Mounting details.Gate Locations.

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 Engineer and owners, and other information specified.

D. Product Test Reports: Based on evaluation of tests performed by manufacturer and witnessed by a qualified independent professional engineer, indicate compliance of gates for applicable codes, based on comprehensive testing within the last two years of current products.

E. Maintenance Data: For gates to include in the maintenance manuals specified in Division 1. Include name, address, and telephone number of manufacturer's nearest authorized service representative.

F. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. The equipment specified herein shall be located as shown or described and installed in conformance with the manufacturer’s suggested method as approved by the Engineer.

B. All of the equipment specified under this Section shall be furnished by a single manufacturer with a minimum of 10 years experience designing and manufacturing water control gates. The manufacturer shall have manufactured water control gates for a minimum of 100 projects.

C. Source Limitations: Obtain each gate component as a complete unit from one source and by a single manufacturer.

D. Comply with all safety regulations for gates.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store gate in a manner to avoid significant or permanent damage to equipment.

1. In general, comply with the manufacturer's written instructions for storage of gates.
2. The equipment shall be stored in a clean, dry location free from construction dust, precipitation and excess moisture.

1.6 WARRANTY

A. Gate Warranty: Submit a written warranty, executed by manufacturer, agreeing to repair or replace gate components that fail in materials or workmanship within the specified warranty period.

B. Warranty Period: One year from date of Substantial Completion.

1. Warranty shall be for unlimited usage of the equipment for the specified rated capacity over the term of the warranty.

1.7 MAINTENANCE SERVICE

A. Contractor shall provide a manufacturer's technical representative for the equipment specified at the jobsite and/or classroom designated by the Owner for the minimum person days listed for the services listed below:

1. One (1) person days for installation assistance, inspection, functional and performance testing, and certification of the installation.
2. One (1) person day for start up.
3. Start up services shall be at times requested by the Contractor and as finally approved by the Owner.

B. Spare Parts

1. Contractor shall furnish to the Owner one set of all special tools required for the proper servicing of all equipment supplied under these specifications.
2. Contractor shall furnish all spare parts not including required lubrication as recommended by the manufacturer for one year's normal operation and maintenance of the equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Slide Gates - Stainless Steel

    a. Whipps
    b. Waco
    c. Golden Harvest
    d. Waterman Industries
    e. Hydro Gate

2. Weir Gates – Stainless Steel

    a. Whipps
    b. Waco
    c. Golden Harvest
    d. Waterman Industries
    e. Hydro Gate

3. Heavy Duty Electric Wrenches (Portable)

    a. Milwaukee.
    b. Approved Equivalent.

2.2 SLIDE GATES (STAINLESS STEEL)

A. General:

1. Gates shall be as specified herein and have the characteristics and dimensions shown on the Contract Drawings.
2. The gate shall utilize self-adjusting seals. Due to the difficulty of accessing gates when they are in service, gates that utilize adjustable wedges, wedging devices or pressure pads are not acceptable.
3. All structural components of the frame and slide shall be fabricated of 304 stainless steel having a minimum thickness of 1/4-inch and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.
4. Slide gate frames shall be shipped fully assembled with the invert member welded to the side frames and the slide installed in the frame unless the overall width of the slide gate exceeds 96 inches or the overall height of the slide gate exceed 25 feet.
5. All welds shall be performed by welders with AWS D1.6 certification.
6. Finish: Mill finish on stainless steel. Welds shall be sandblasted to remove weld burn and scale. All iron and steel components shall be properly prepared and shop coated with a primer.

B. Frame:

1. The frame assembly, including the guide members, invert member and yoke members, shall be constructed of formed stainless steel plate with a minimum thickness of 1/4-inch.
2. Frame design shall allow for embedded mounting, mounting directly to a wall with stainless steel anchor bolts and grout or mounting to a wall thimble with stainless steel mounting studs and a mastic gasket material. Mounting style shall be as shown on the Contract Drawings.
3. All wall mounted or wall thimble mounted gates shall have a flange frame. Flat frame gates are not acceptable.
4. The structural portion of the frame that incorporates the seat/seals shall be formed into a one-piece shape for rigidity. Guide members that consist of two or more bolted structural members are not acceptable. Guide member designs where water loads are transferred through the assembly bolts are specifically not acceptable.
5. Gussets shall be provided as necessary to support the guide members in an unseating head condition. The gussets shall extend to support the outer portion of the guide assembly and shall be positioned to ensure that the load is transferred to the anchor bolts or the wall thimble studs.
6. The frame shall extend to accommodate the entire height of the slide when the slide is in the fully opened position on upward opening gates or downward opening weir gates.
7. On self-contained gates, a yoke shall be provided across the top of the frame. The yoke shall be formed by two structural members affixed to the top of the side frame members to provide a one-piece rigid assembly. The yoke shall be designed to allow removal of the slide.
8. A rigid stainless steel invert member shall be provided across the bottom of the opening. The invert member shall be of the flushbottom type on upward opening gates.
9. A rigid stainless steel top seal member shall be provided across the top of the opening on gates designed to cover submerged openings.

10. A rigid stainless steel member shall be provided across the invert of the opening on downward opening weir gates.

C. Slide:

1. The slide and reinforcing stiffeners shall be constructed of stainless steel plate. All structural components shall have a minimum thickness of 1/4-inch.
2. The slide shall not deflect more than 1/360 of the span or 1/16 inch, whichever is smaller, under the maximum design head.
3. When the width of the gate opening multiplied by the maximum design head is greater than 120 square feet, the portion of the slide that engages the guide members shall be of a “thick edge” design. Minimum material thickness of all members of the slide shall be ¼ inch (6 mm).
4. Reinforcing stiffeners shall be welded to the slide and mounted horizontally. Vertical stiffeners shall be welded on the outside of the horizontal stiffeners for additional reinforcement.
5. The stem connector shall be constructed of two angles or plates. The stem connector shall be welded to the slide. A minimum of two bolts shall connect the stem to the stem connector.

D. Stems:

1. A threaded operating stem shall be utilized to connect the operating mechanism to the slide. On rising stem gates, the threaded portion shall engage the operating nut in the manual operator or motor actuator. On non-rising stem gates, the threaded portion shall engage the nut on the slide.
2. The threaded portion of the stem shall have a minimum outside diameter of 1-1/2 inches. Stem extension pipes are not acceptable.
3. The stem shall be constructed of solid stainless steel bar for the entire length, the metal having a tensile strength of not less than 75,000 psi.
4. The stem shall be threaded to allow full travel of the slide unless the travel distance is otherwise shown on the Contract Drawings.
5. Maximum L/R ratio for the unsupported part of the stem shall not exceed 200.
6. In compression, the stem shall be designed for a critical buckling load caused by a 40 lb effort on the crank or handwheel with a safety factor of 2, using the Euler column formula.
7. The stem shall be designed to withstand the tension load caused by the application of a 40 lb effort on the crank or handwheel without exceeding 1/5 of the ultimate tensile strength of the stem material.
8. The threaded portion of the stem shall have machine rolled threads of the full Acme type with a 16 microinch finish or better. Stub threads are not acceptable.
9. Stems of more than one section shall be joined by stainless steel or bronze couplings. The coupling shall be bolted to the stems.
10. Stems, on manually operated gates, shall be provided with adjustable stop collars to prevent over closing of the slide.

E. Seals:

1. All gates shall be provided with a self-adjusting seal system to restrict leakage in accordance with the requirements listed in this specification.

2. All gates shall be equipped with UHMW polyethylene seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide.
3. The seat/seals shall extend to accommodate the 1-1/2 x the height of the slide when the slide is in the fully closed or fully opened position.
4. All upward opening gates shall be provided with a resilient seal to seal the bottom portion of the gate. The seal shall be attached to the invert member or the bottom of the slide and it shall be held in place with stainless steel attachment hardware.
5. All downward opening weir gates shall be provided with UHMW polyethylene seat/seals across the invert member.
6. The seal system shall be durable and shall be designed to accommodate high velocities and frequent cycling without loosening or suffering damage.
7. All seals must be bolted or otherwise mechanically fastened to the frame or slide. Arrangement with seals that are force fit or held in place with adhesives are unacceptable.
8. The seals shall be mounted so as not to obstruct the water way opening.
9. Gates that utilize rubber “J” seals or “P” seals are not acceptable.
10. The seal system shall have been factory tested to confirm negligible wear (less than 0.01”) and proper sealing. The factory testing shall consist of an accelerated wear test comprised of a minimum of 25,000 open-close cycles using a well-agitated sand/water mixture to simulate fluidized grit.

F. Manual Operators:

1. Unless otherwise shown on the Drawings, gates shall be operated by a manual handwheel or a manual crank-operated gearbox. The operator shall be mounted on the yoke of self-contained gates or on the pedestal of non-self-contained gates.
2. The gate manufacturer shall select the proper gear ratio to ensure that the gate can be operated with no more than a 25 lb effort when the gate is in the closed position and experiencing the maximum operating head.
3. An arrow with the word "OPEN" shall be permanently attached or cast onto the operator to indicate the direction or rotation to open the gate.
4. Handwheel operators shall be fully enclosed and shall have a cast aluminum housing.

    a. Handwheel operators shall be provided with a threaded cast bronze lift nut to engage the operating stem.
    b. Handwheel operators shall be equipped with roller bearings above and below the operating nut.
    c. Positive mechanical seals shall be provided above and below the operating nut to exclude moisture and dirt and prevent leakage of lubricant out of the hoist.
    d. The handwheel shall be removable and shall have a minimum diameter of 16 inches.

5. Crank-operated gearboxes shall be fully enclosed and shall have a cast aluminum or ductile iron housing.

a. Gearboxes shall have either single or double gear reduction depending upon the lifting capacity required.
b. Gearboxes shall be provided with a threaded cast bronze lift nut to engage the operating stem.
c. Bearings shall be provided above and below the flange on the operating nut to support both opening and closing thrusts.
d. Gears shall be steel with machined cut teeth designed for smooth operation.
e. The pinion shaft shall be stainless steel and shall be supported on ball or tapered roller bearings.
f. Positive mechanical seals shall be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist.
g. The crank shall be cast aluminum or cast iron with a revolving nylon grip and have a minimum radius of 12”.
h. The crank shall be removable.

6. All gates having widths in excess of 72 inches and widths greater than twice their height shall be provided with two gearboxes connected by an interconnecting shaft for simultaneous operation.

    a. Interconnecting shafting shall be constructed of aluminum or stainless steel.
    b. Flexible couplings shall be provided at each end of the interconnecting shaft. Couplings shall be stainless steel or non-metallic.
    c. One crank shall be provided to mount on the pinion shaft of one of the gearboxes.

7. An extended operator system utilizing chain and sprockets shall be furnished by the manufacturer when the centerline of the crank or handwheel, on a non-geared operator, is located over 48-in above the operating floor. Chain wheels are not acceptable.

    a. A removable stainless steel or aluminum cover shall be provided to enclose chain and sprockets.
    b. The extended operator system shall lower the centerline of the pinion shaft to 36-in above the operating floor.
    c. A handwheel may be utilized in conjunction with a gearbox in lieu of the extended operator system if the centerline of the pinion shaft is 60-in or less above the operating floor.

8. Pedestals shall be constructed of stainless steel. Aluminum pedestals are not acceptable.

    a. The pedestal height shall be such that the handwheel or pinion shaft on the crank-operated gearbox is located approximately 36-in above the operating floor.
    b. Wall brackets shall be used to support floor stands where shown on the Drawings and shall be constructed of stainless steel.
    c. Wall brackets shall be reinforced to withstand in compression at least two times the rated output of the operator with a 40 lb effort on the crank or handwheel.

d. The design and detail of the brackets and anchor bolts shall be provided by the gate manufacturer and shall be approved by the ENGINEER. The gate manufacturer shall supply the bracket, anchor bolts and accessories as part of the gate assembly.

9. Operators shall be equipped with fracture-resistant clear butyrate or lexan plastic stem covers.

    a. The top of the stem cover shall be closed and have a ventilation hole.
    b. The bottom end of the stem cover shall be mounted in a housing or adapter for easy field mounting.
    c. Stem covers shall be complete with indicator markings to indicate gate position.

10. When shown on the Contract Drawings, provide 2 inch square nut, mounted in a floor box, with a non-rising stem.

    a. The square nut shall be constructed of bronze.
    b. The floor box shall be constructed of stainless steel or cast iron and shall be set in the concrete floor above the gate as shown.

11. Provide one aluminum or stainless steel T-handle wrench for operation.

G. Anchor Bolts:

1. Anchor bolts shall be provided by the gate manufacturer for mounting the gates and appurtenances.
2. If epoxy type anchor bolts are provided, the gate manufacturer shall provide the studs and nuts.
3. Anchor bolts shall have a minimum diameter of 1/2-inch.

2.3 WEIR GATES

A. Weir gates shall be similar in construction to that specified for Slide Gates (Ultra Leak Tight Service) and shall be designed such that the upper edge of slide functions as an adjustable weir.

B. The section of gate below the liquid level shall be tightly sealed against the frame and bottom closure member such that watertight shut off can be achieved.

2.4 GATE SCHEDULE

TYPE	QTY	SIZE (W x H)	LOCATION	OPERATOR
SURFACE-MOUNTED SLIDE GATE	1	30” x 30”	OVERFLOW STRUCTURE	BRACKET-MOUNTED PEDESTAL AND HAND CRANK
SURFACE-MOUNTED SLIDE GATE	1	42” x 42”	OVERFLOW STRUCTURE	BRACKET-MOUNTED PEDESTAL AND HAND CRANK

SELF-CONTAINED SLIDE GATE	4	36" x 60"	HEADWORKS	HAND CRANK
SELF-CONTAINED SLIDE GATE	3	48" x 60"	HEADWORKS	HAND CRANK
SELF-CONTAINED WEIR GATE	2	48” x 48”	HEADWORKS	HAND CRANK
SURFACE-MOUNTED SLIDE GATE	5	12” x 12”	AERATION BASIN	BRACKET-MOUNTED PEDESTAL AND HAND CRANK
SELF-CONTAINED WEIR GATE	2	72” x 24”	CLARIFIER SPLITTER BOX	BRACKET-MOUNTED PEDESTAL AND HAND CRANK
SURFACE-MOUNTED SLIDE GATE	2	18” x 18”	FILTERS	BRACKET-MOUNTED PEDESTAL AND HAND CRANK
SELF-CONTAINED WEIR GATE	4	48.25” x 50”	UV DISINFECTION	ELECTRIC ACTUATOR

2.5 ELECTRIC WRENCHES

A. Electric wrenches shall:

1. Be double insulated capable of being operated with safety in adverse wet conditions.
2. Adjustable height tri-pod stand
3. Be suitable for operation on 120 volt, single phase 60 Hz.
4. Reversing switch, over-torque protection clutch, and 20 foot cord
5. Maximum output torque by the clutch shall match the requirement for manual input to prevent damage to the operator or gate, and potential injury to personnel.
6. Operator speed shall move the gate at approximately 12 inches per minute rate.

B. A total of one (1) electric wrench shall be delivered to the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of gates.

3.2 INSTALLATION, GENERAL

A. General: Comply with manufacturer's detailed written instructions for installing gates.

3.3 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure gate is without damage or deterioration at the time of Substantial Completion.

3.4 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 33 12 15

SECTION 33 39 13 - MANHOLES AND APPURTENANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for manholes and appurtenances, including the following:

1. Precast concrete manholes.
2. Manhole castings.
3. Manhole steps.
4. Flexible joints for manhole-sewer connections.
5. Manhole testing.

1.3 SUBMITTALS

A. Shop Drawings:

1. Include plans, elevations, details, and attachments for the following:

a. Precast concrete manholes.
b. Manhole frames and covers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

A. Precast concrete manholes shall be of the following types and sizes:

1. Standard Manholes: Manhole barrel diameter 4'-0" for use on sewers less than 24 inches in diameter.
2. Type I Manhole: Manhole barrel diameter 5'-0" for use on sewers 24 inches through 36 inches in diameter.
3. Type IA Manhole: Manhole barrel diameter 6'-0" for use on sewers 42 inches through 48 inches in diameter.

B. The precast reinforced concrete manholes shall be constructed in accordance with ASTM Standard Requirements for Precast Reinforced Concrete Manholes, ASTM Designation C-478, latest revision.

1. Concrete: Shall have a minimum compressive strength of 4,000 psi at 28 days.
2. Cement: Shall be Type II with C3A content of 5.5% or less.
3. Manhole Surfaces: The interior and exterior surfaces of the manholes shall have smooth hard finish; and shall be free from cracks, chips and spalls.
4. Coatings:

    a. The interior surfaces of the manhole shall be coated with a high-build glass-flake Cementitious epoxy coating to dry film thickness of not less than 20 mils. Cementitious epoxy coating shall be PCS-9043 Type II Coating as manufactured by Permite Coatings, or equivalent.

5. Ballast: Increase thickness of precast concrete sections or add concrete to base section, if required to prevent flotation.
6. Base Section:

    a. 6-inch minimum thickness for floor slab.
    b. 4-inch minimum thickness for walls and base riser section.
    c. Having base section with integral floor.
    d. For installation on existing storm sewers, having no floor and vertically slotted openings. This base section configuration is commonly referred to as “doghouse”.
    e. Shall be fabricated with two non-penetrating lifting inserts.

        1) Lifting inserts shall be Manhole Lifting System inserts as manufactured by Press-Seal GASKET Corporation or equivalent.
        2) Lifting eye bolts manufactured by the insert manufacturer shall be supplied to the Contractor.

7. Riser Sections:

    a. 4-inch minimum thickness.
    b. Risers shall be furnished in suitable increments to an elevation (for the particular manhole) not more than 12 inches below the base of the cast iron frame and cover to be set on that particular manhole.
    c. Maximum elevation of riser shall be that which will permit setting top of manhole frame at the appropriate finished grade.
    d. Shall be fabricated with two non-penetrating lifting inserts.

        1) Lifting inserts shall be Manhole Lifting System inserts as manufactured by Press-Seal GASKET Corporation or equivalent.
        2) Lifting eye bolts manufactured by the insert manufacturer shall be supplied to the Contractor.

    e. All riser sections shall be secured with stainless steel anchor assemblies spaced 120 degrees apart at the joint between riser sections.
    f. Manhole diameters shall not be less than that required to maintain minimum dimension between adjacent pipe penetrations in accordance with manhole manufacturer’s recommendations or the Jefferson County Standard Sanitary Sewer Specifications, whichever is more stringent.

8. Top Section:

a. May be eccentric-cone type or concentric-cone type.
b. Shall be suitable for mounting cast iron manhole frames and covers described in these Specifications.
c. Shall be fabricated with two non-penetrating lifting inserts.

1) Lifting inserts shall be Manhole Lifting System inserts as manufactured by Press-Seal GASKET Corporation or equivalent.
2) Lifting eye bolts manufactured by the insert manufacturer shall be supplied to the Contractor.

9. Joints between manhole sections:

a. Joints between manhole sections shall be offset tongue and groove type.
b. Joints shall be installed using a prelubricated manhole gasket which shall conform to the following requirements:

1) Gasket shall consist of a compression section and a serrated mantel section which slides over the compression section as the manhole sections are placed together.
2) Gasket shall meet the requirements of ASTM C 443.
3) The manhole gasket shall be Tylox Super-Seal manufactured by Hamilton Kent, Ltd. of Canada, or Engineer-approved equivalent.

10. Grade Rings:

a. Include two or three reinforced-concrete rings.
b. Rings shall be 6- to 9-inch total thickness.
c. Rings shall match cast iron manhole frames and covers described in these Specifications.

2.2 MANHOLE CASTINGS

A. Manhole frames and covers shall be cast from gray iron meeting the requirements of ANSI/ASTM A 48-83, not less than Class 30.

B. Manhole frames and covers shall conform to the following requirements:

1. All castings shall be free from scale, lumps, blisters, sand holes and other defects that would render them unfit for the service for which they are intended.
2. Manhole covers shall be of the solid indented pattern, and shall be lettered as indicated.
3. Bearing surfaces of frames and covers shall be machined to secure a solid bearing and to prevent rocking, and the fit of the cover in the frame shall be tight (close) so as to prevent flipping.
4. Castings having uneven bearing between cover and frame or loose-fitting covers shall be rejected.
5. The Contractor shall submit for review by the Engineer, pattern drawings of manhole castings.
6. Frames and covers installed on manholes located in open areas shall weigh not less than 290#, and frames and covers installed on manholes in locations subject

to traffic shall weight not less than 375#.

7. All manhole covers (lids) shall be self-sealing type and shall have no through pick-holes.
8. Manholes frames and covers shall be equivalent in quality to manufacturer of Neenah Foundry Company or Barry Pattern & Foundry Company.
9. Manhole frames and covers shall be U.S. Foundry and Manufacturing Corporation Model No. 576 ring and Model BH cover.

C. Where indicated, waterproof (watertight) manhole frames and covers shall be furnished and installed and shall conform to the following requirements:

1. Waterproof manhole frames and covers shall have bolted-on covers with round rubber gaskets for watertight sealing under sub-aqueous service.
2. Waterproof manhole frames and covers shall be similar and equivalent to Neenah Catalog No. R-1916-E, or similar product of Barry Pattern & Foundry Company or equivalent.
3. Bottom flanges of manhole frames shall have three (3) ¾" diameter holes bored and spaced at 120° around flange for anchor bolts when manholes are set in such locations requiring anchorage of covers as specified in the preceding paragraph.
4. Waterproof manhole frames and covers shall be U.S. Foundry and Manufacturing Corporation Model No. 576 ring and Model BH cover, both tapped for bolts and supplied with gaskets as described above.

D. In order for each manhole to be correctly assembled to suit construction conditions existing at particular locations, all components of each manhole shall be clearly marked.

2.3 MANHOLE STEPS

A. Manhole steps shall conform to the following requirements:

1. All steps shall meet the requirements of the Occupational Safety and Health Standards, U.S. Department of Labor.
2. All types of steps shall be specially designed and suitable for use in precast concrete manholes.

B. Types of steps shall be as follows:

1. Gray iron ASTM A 48-83 or ductile iron integrally cast in barrels of manholes.
2. Gray iron ASTM A 48-83 or ductile iron, equipped with inserts integrally cast in barrels of manholes and having steps bolted on.
3. Copolymer polypropylene plastic meeting the requirements of ASTM D 2146.

    a. Shall be reinforced with ½" diameter deformed bar meeting the requirements of ASTM A 615, with inserted ends corrugated for bond, and integrally cast in barrels of manholes.

2.4 OPENINGS FOR SEWER PIPES

A. Openings for sewer pipes shall be provided in the manhole sections at positions as required by alignment and elevations.

B. Openings may be cast into the manhole wall or mechanically cored.

C. Sewer pipes that do not require flexible joints shall be sealed into the manhole wall with mortar.

D. Such openings in manhole walls shall be large enough to permit variations in both vertical and horizontal position as field conditions may dictate.

E. Mortar for sealing pipelines into manhole shall be one part Portland cement (Type II) and two parts sand by volume.

F. Enough water shall be used in the mixture to produce a stiff workable mix but shall not exceed five and one-half gallons per sack of cement.

2.5 FLEXIBLE JOINTS FOR MANHOLE-SEWER CONNECTIONS

A. Flexible joints or flexible connectors, for connection of sewers smaller than 24 inches in diameter to manholes shall be either of the two following types:

1. Complete joint with insert piece pre-cast into wall of manhole and comprised of the following components:

a. Cast iron insert ring, ASTM A48, Class 20, tapped ½ inch to receive draw bolts
b. Cast iron compression flange, ASTM A48, Class 20
c. Corten draw bolts with washers and nuts
d. Rubber "O" -ring gasket, ASTM C443

2. Complete joint with seal assembly inserted in hole cored in manhole wall and comprised of the following components:

a. Rubber or neoprene boot.
b. Stainless steel seal band.
c. Stainless steel pipe clamp.

PART 3 - EXECUTION

3.1 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Form continuous concrete channels and benches between inlets and outlet.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

D. Install precast concrete manhole sections with gaskets according to ASTM C 891.

E. All precast concrete manholes shall be set on foundation bed of compacted crusher run stone, choked with fines, 12 inch minimum thickness, and covering the entire bottom of the excavation for the manhole.

3.2 MANHOLE TESTING

A. All new manholes shall be tested by the Contractor using the vacuum test method, following the manufacturer's recommendations for proper and safe procedures.

B. Any leakage in the manhole or structure, before, during, or after the test shall be repaired.

C. All pipes for vacuum testing entering the manhole shall be installed at the top access point of the manhole.

D. A vacuum of 10 inches of mercury (Hg) (5.0 psi) shall be drawn on the manhole, and the time shall be measured for the vacuum to drop to 9 inches of mercury (Hg) (4.5).

E. Manholes will be considered to have failed the vacuum test if the time to drop 1 inch of mercury is less than what is shown in the following table:

VACUUM TEST TIMETABLE

	Manhole Diameter			
Depth (ft.)	48 inches	60 inches	72 inches	96 inches
4	10 sec.	13 sec.	16 sec.	19 sec.
8	20 sec.	26 sec.	32 sec.	38 sec.
12	30 sec	39 sec.	48 sec.	57 sec.
16	40 sec.	52 sec.	64 sec.	76 sec.
20	50 sec.	65 sec.	80 sec.	95 sec.
+ Each 2 ft.	+ 5 sec.	+ 6.5 sec.	+ 8 sec.	+9.5 sec.

F. Manhole depths shall be rounded to the nearest foot.

G. Intermediate values shall be interpolated.

H. For depths above 20 feet, add the values listed in the last line of the table for every 2 feet of additional depth.

I. If the manhole or structure fails the vacuum test, the Contractor shall perform additional repairs and repeat the test procedures until satisfactory results are obtained.

END OF SECTION 33 39 13

SECTION 33 41 00 - STORM DRAINAGE

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. This Section includes storm drainage outside the building.

1.3 PROJECT CONDITIONS

A. Site Information: Verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.

PART 2 - PRODUCTS

2.1 PRECAST GRATE INLETS

A. Precast Concrete Catch Basins: ASTM C 913, Class 700, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints. Designed according to ASTM C 890 for A-16, heavy traffic, structural loading.

1. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having base section with integral floor.
2. Riser Sections: 5-inch minimum thickness and lengths to provide depth indicated.
3. Top Section: Flat-slab-top type.
4. Gaskets: ASTM C 443, rubber.
5. Steps: Same as specified for manholes. Omit steps for catch basins less than 60 inches deep.

B. Ductile Iron Frames and Grates: ASTM A 536, Grade 65-45-12, ductile iron designed for heavy-duty service. Include ductile iron flat grate with small square or short-slotted drainage openings as indicated.

C. Cast Iron Frames and Grates: Shall conform to the Standard Specifications for Gray Iron Castings, ASTM Specification A-48, not less than Class 20.

D. Frames and Grates for Precast Grate Inlets installed in Unpaved Areas: Shall be iron

castings conforming to ASTM Standard Specifications for Grey Iron Castings, Serial Designation A-38-60T, Class 20.

2.2 CONCRETE FOR CAST-IN-PLACE DRAINAGE STRUCTURES

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.3 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Flared End Sections: Precast reinforced concrete per details of applicable state DOT.

C. Special Outlet Structures: Cast-in-place reinforced concrete as indicated.

2.4 FRENCH DRAIN SYSTEM

A. French drain system shall be installed at locations indicated.

B. The drain system shall consist of perforated plastic pipe surrounded with crushed stone which is wrapped with filter fabric. The material shall be as described hereinbelow.

C. Perforated plastic drain pipe shall conform to the following requirements:

1. Shall be 4" diameter corrugated PVC material.
2. Perforations shall be 3/4" diameter.
3. Perforations shall be equally spaced around the diameter of the pipe (separated by 120).
4. Each set of three holes should be spaced at 4" along the pipe length.
5. Sections of the pipe shall be joined with similar material sleeves or couplings designed for that purpose.

D. Crushed stone shall meet State Department of Transportation requirements (for clean stone (no fines). The crushed stone shall be placed as detailed.

E. Filter fabric shall be nonwoven geotextile fabric of polypropylene or polyester fibers, or a combination of both. The fabric will be placed completely around the perimeter of the crushed stone.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. If applicable, install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

1. Install piping sloped down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install piping with 36-inch minimum cover.

F. If applicable, extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

G. Jacking and Boring: Install pipe under streets or other obstructions that cannot be disturbed by jacking and boring.

3.2 GRATE INLET INSTALLATION

A. Construct grate inlet to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.3 STORM DRAINAGE INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Install outlets that spill onto grade, anchored with concrete, where indicated.

3.4 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to Division 3 Section “Cast-in-place Concrete.”

3.5 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.

B. Make branch connections into existing piping or to existing underground structures by cutting opening into existing unit large enough to allow 2 inches of grout to be packed into entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 12 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

1. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
2. Use non-shrink, non-metallic grout for the connection.

C. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.6 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use one procedure below:

1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
3. Wedge wooden form or plastic plug 12 inches inside pipe. Fill end of pipe with plain concrete and continue pour until a solid cap encloses the pipe end. Minimum cap dimensions shall be 24 inches by pipe OD plus 12 inches.

B. Abandoned Structures: Excavate around structure as required and use one procedure below:

1. Remove structure and close open ends of remaining piping.
2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with plain concrete.
3. Backfill to grade according to Division 2 Section "Earthwork."

3.7 PIPELAYING

A. Minimum depth of cover for all pipe shall be 3'-0" unless otherwise shown. The Contractor shall excavate the trenches to such depths required to obtain the cover specified hereinabove or as indicated.

B. Ductile Iron Pipe

1. Installation and joining of ductile iron pipe shall be performed in accordance with the requirements of ANSI/AWWA C600, latest revision, and with the requirements of these Specifications.
2. Ductile iron pipe shall be installed so as to conform to the alignment and grade indicated.

    a. If other utilities, pipe, cables, conduits, etc., are encountered they shall be handled as described in these Specifications.

3. Ductile iron pipe shall be laid so that the invert elevations will correspond to those indicated for the particular stations along the pipe line.

    a. The difference in elevation between any two consecutive grade points (elevation control points or stations) shall be uniformly and proportionately distributed between the pipe lengths comprising the section of pipe line between such control points.
    b. The maximum deflection for a particular size and length of pipe shall be in accordance with the manufacturer's recommendations.

4. Proper and suitable tools and appliances for handling of the pipe shall be used.
5. The bottom of the trench shall be prepared as described in these Specifications.
6. Each piece of pipe or fitting shall be cleaned and carefully examined for defect.
7. No defective pipe or fittings shall be used.

    a. If a defective piece should be discovered after having been used it shall be removed and replaced with a non-detective piece by the Contractor at the Contractor's expense.

8. The pipe shall be accurately installed to the lines and grades indicated
9. Whenever a length of pipe requires cutting to fit the lines, it shall be done as to leave a smooth end at right angles to the axis of the line; and the Contractor shall not receive extra compensation for this work.
10. Open ends of the unfinished pipe line shall be securely closed when the work is stopped temporarily at night or other times.

C. PVC Pipe Sewers

1. Pipe shall be installed in trenches in accordance with the requirements of ASTM D 2321-83a and in accordance with the requirements of these Specifications.
2. The pipe shall be accurately laid to the lines and grades indicated.
3. All dirt, excavated materials or other foreign materials shall be prevented from entering the pipe.
4. Each piece of pipe, before being lowered into the trenches, shall have been cleaned, shall have been examined for defects, and shall have been judged to be suitable for installation in the pipeline.
5. The first length of pipe installed at any starting point in the pipeline shall be firmly anchored to prevent movement by completion of bedding and backfilling operation before the next length of pipe is installed.

D. Reinforced Concrete Drain Pipe

1. Installation of reinforced concrete drain pipe shall be performed in accordance with the requirements of these Specifications.
2. In the case where tongue-and-groove pipe may be installed, the joint surfaces shall be thoroughly cleaned, and the annular space shall then be completely filled with a plastic joining material similar and equal to Ram-Nek.
3. The joint shall be made in accordance with the recommendations of the manufacturer of the joining material.
4. Where pipe is furnished with ends suitable for an O-ring joint, all joint surfaces and gasket recesses shall be thoroughly cleaned, the gaskets shall be first thoroughly cleaned and then lubricated, and the joints shall be made-up in accordance with the pipe manufacturer's recommendations.

3.8 BRACING OF PIPE AND FITTINGS

A. All piping shall be braced against internal thrust by means of restrained joints and/or poured-in-placed concrete bracing where changes in direction occur or where branches from the line are located.

B. Braced underground piping shall be securely braced against movement with concrete thrust blocks and bearing against solid, undisturbed ground.

1. Where solid or undisturbed ground cannot be obtained for bracing or where indicated on the Drawings restrained joint pipe and/or fitting shall be required.

C. Concrete braces shall be constructed in accordance with details shown on the Drawings; and shall be plain or reinforced as indicated or required.

1. All reinforced concrete used in underground bracing shall be "Class A" concrete in accordance with the requirements of these Specifications.

D. Special bracing for particular locations identified on the Drawings and/or described herein shall be in accordance with details shown on the Drawings for the particular special brace and shall be complete with reinforcing steel and miscellaneous metal work.

E. Piping installed above ground in buildings, galleries, tunnels, piping trenches and chases shall be supported and braced as indicated on the Drawings and specified herein.

1. Where pipes are braced or supported above ground piping by means of concrete piers or thrust blocks, the concrete used for construction of such piers or thrust blocks shall be:

a. Class "A" as specified in these Specifications
b. Reinforced
c. Anchored to slabs and/or walls by dowels
d. Finished to match adjacent concrete surfaces or finished surfaces of adjacent walls or floors, whichever is applicable

3.9 CONNECTIONS TO EXISTING SYSTEM

A. The Contractor shall make all connections to existing mains as indicated and as specified herein.

1. These connections shall be made at such times and in such manner as will keep to a minimum any interruptions of service or inconvenience to users of the system.
2. Connections to the existing system shall only be made after obtaining permission from the Owner specifically for each connection.

3.10 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and when work stops.
3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
3. Reinspect and repeat procedure until results are satisfactory.

C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate reports for each test.

END OF SECTION 33 41 00

SECTION 33 41 14 - CONCRETE PIPE AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for Concrete pipe and fittings including the following:
   1. Reinforced Concrete Sewer Pipe.
   2. Reinforced Concrete Drainage Pipe.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

   1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
   3. Power and control wiring diagrams, including terminals and numbers.
   4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
   5. Factory finish system.

1.4 DEFINITIONS

A. RCP: Reinforced Concrete Pipe.

B. RCPA: Reinforced Concrete Pipe-Arch.

1.5 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall provide the proper equipment, tools and facilities necessary for the efficient prosecution of the work.

   1. Materials damaged in unloading, handling or installation shall be promptly discarded and removed from the area of the work.
   2. No pipe shall be unloaded or moved by allowing the pipe to roll, slide or fall to the ground or to cushions placed on the ground.
   3. No pipe, fittings, valves, etc., shall be unloaded by inserting loader blades, teeth, etc., into the pipe interior.

B. Pipe shall be stored on racks or timbers in such a manner that pipe ends are above the ground surface.

1. When pipe is to be moved it shall not be dragged or rolled but shall be lifted by use of a sling designed to prevent damage to the pipe coatings.
2. Should an intermediate placement of the pipe along the side of the trench be required, the pipe shall be placed on racks or timbers along the side of the trench in manner as specified hereinabove.

C. Each length or section of pipe shall be cleaned immediately before being placed in the trench and joined.

1. Cleaning shall be accomplished by use of a tight swab or other suitable cleaning device.
2. If necessary a brush pig shall be run through the section of pipe prior to final swabbing.
3. Pipe ends shall be wiped clean before the pipe is joined.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL AND FITTINGS

A. The contractor shall carefully examine all pipe and piping materials before placing them in the work.

1. If any such pipe or materials should be found to be defective, the Contractor shall promptly notify the Engineer and discard such pipe and materials.

B. The interior of all pipe, fittings, valves and accessories shall be kept free from dirt and foreign material.

1. Suitable bulkheads shall be used to block or plug ends of piping at the close of each work day and when work on a particular section of piping is temporarily discontinued.
2. Should dirt, mud, concrete, laitance, paint or other foreign materials be allowed to enter the piping or any section of piping, such piping or section of piping shall immediately be cleaned.

C. Piping materials shall be of the types, classes and sizes shown or as specified in the piping schedule.

D. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, Class III, Wall B, for gasketed or mortared joints.

1. Gaskets: ASTM C 443, rubber.
2. Joint Mortar: A mixture of Portland cement, sand, and water. One part Portland cement and two parts sand by volume. Add water sufficient for a stiff, workable mortar without exceeding 5½ gallons per sack of cement. Sand shall confirm to ASTM C144. Portland cement shall conform to ASTM C150.

E. Reinforced Concrete Sewer Pipe-Arch: ASTM C 506, Class A-III, for mortared joints.

1. Joint mortar: Same as for round RCP.

2.2 REINFORCED CONCRETE SEWER PIPE

A. Reinforced concrete pipe used in conveying sewage shall conform to the ASTM Standard Specifications for Reinforced Concrete Culvert Pipe, Serial Designation C-76, except as specifically extended, modified, and/or amended herein.

B. All reinforced concrete sewer pipe shall meet the following standards for ASTM C76 for the following depths of cut:

1. Class III pipe for cuts 0-10 feet.
2. Class IV for cuts 10-20 feet.
3. Class V for cuts in excess of 20 feet unless specifically modified or amended in the plans or specifications.

C. All reinforced concrete sewer pipe will have a minimum of ASTM C76B wall thickness unless specifically modified or amended herein.

D. Steel end ring concrete pipe manufactured in accordance to ASTM C76 shall be furnished in not more than sixteen (16) foot lengths and not less than twelve (12) foot lengths.

E. Bell and spigot concrete pipe manufactured in accordance with ASTM C76 shall be furnished in not more than sixteen (16) foot lengths and not less than eight (8) foot lengths.

F. Special pieces and closure pieces may be of shorter lengths than specified herein.

G. Pipe shall be manufactured wet cast, dry cast or centrifugally cast or by the re-densification method.

H. No lifting holes shall be provided in the shell of the pipe.

1. Care shall be exercised in handling and transporting the pipe so as to protect the full interior wall of the pipe.
2. No inward projecting hooks or lift bars shall be used in lifting pipe.
3. Extreme care shall be applied to handling pipe immediately after manufacture to prevent development of "cure" cracks and stress cracks due to transporting pipe before full length of curing time.

I. Concrete

1. Concrete used for making all reinforced concrete pipe shall have minimum compressive strength of 6000 psi at 28 days and the absorption shall not exceed 6.0 percent.
2. Cement and aggregate used in the mix shall conform to the requirements of ASTM Specifications C-76, latest revision.
3. Maximum size of aggregate for particular wall thickness shall be such that a workable, homogeneous, concrete mixture of high quality and strength will be secured.

4. Aggregate shall be limestone well graded and cement shall be Type II Portland cement.
5. Admixtures shall be as approved by the Engineer.
6. These requirements apply to pipe manufactured in accordance with specifications of ASTM C-76, latest revision.
7. The pipe manufacturer shall be required prior to manufacturing any pipe, including test pipe, to submit to the Engineer the proposed concrete mix design and procedures that he will use for steam curing, to include curing duration and temperature.

J. Reinforcement

1. Reinforcement shall consist of either:

    a. Wire conforming to the standard specification for deformed steel wire for concrete reinforcement (ASTM A 496-latest revision).
    b. Welded deformed steel wire fabric for concrete reinforcement (ASTM A 497 latest revision).
    c. Bars of intermediate grade steel conforming to standard specifications for billet steel bars for concrete reinforcement (ASTM Designation A615, Grade 60 latest revision).
    d. Fabricated deformed steel mats for concrete reinforcing (ASTM A184 latest revision).

2. Pipe shall be reinforced with two full circular steel cages.
3. Elliptical steel cages or quadrant steel cages shall not be allowed.
4. Reinforcing steel shall be positioned in accordance with the clearance specified in ASTM C76 except for 48" pipe and larger, minimum clearance of the inside steel cage shall be 1.75 inches.
5. Clearance shall be provided for the full length of the pipe from bell end to spigot end of the pipe.
6. Steel positioning shall not vary within the forms more than 1/4" in either direction.
7. The manufacturer shall request inspection prior to placing concrete around the steel cages.

    a. For steel end ring-type pipe the Owner's inspector shall, upon completion of the cage, spray the outside of steel spigot end at the welded bead with yellow paint to signify approval.
    b. The manufacturer shall spray the outside steel spigot in the gasket groove with green paint to mark Class III pipe, or blue paint to mark Class IV pipe, or red paint to mark Class V pipe.
    c. The yellow approval paint and the class color of paint shall be left exposed through the manufacturing process.
    d. Should one joint of pipe receive two color codings, the lowest color coding shall be accepted.

8. Spacers shall be required along the full length of the pipe.

    a. Spacers shall be placed at maximum intervals of two feet from ends of pipe joints and shall be not more than three (3) feet max. center to center in any direction.

b. Spacers shall conform to the following requirements:

1) Shall be tied to the inner and outer cage.
2) Shall be high strength spring steel 0.245 inch min. diameter.
3) Shall be bent such that at each form wall there is a 180 degree loop.
4) Shall be rigid and continuous.
5) Shall be positioned onto inner steel reinforcing and outer steel reinforcing without the use of welding.
6) Shall provide proper positioning of inner member (reinforcing) and outer member (reinforcing) with tolerances not to exceed 1/8 inch.

c. The spacer design shall be included in the pipe design submittal.

1) Should the Contractor desire to utilize a design different from that specified above, he must demonstrate to the satisfaction of the Engineer that the spacer will serve its intended purpose.
2) The spacer will be used only so long as it remains satisfactory.
3) The Contractor shall replace at his cost any pipe in which the steel placement is not in accordance with the specifications herein.

K. Joints (Steel End Ring Pipe)

1. Joints in all concrete pipe 24 inches and larger in diameter shall be equipped with steel end rings unless specifically modified or amended elsewhere.

a. The rings which form the joint shall be made so that they will join in a close sliding fit.
b. The joint surfaces shall be such that the rubber gasket shall be confined an all sides and shall not support the weight of the pipe.
c. The spigot ring shall have an external groove accurately sized to receive the gasket.
d. Special section steel for spigot rings shall conform to ASTM A283, Grade A or ASTM A306, Grade 50.
e. The bell ring shall be flared to permit gradual deformation of the gasket when the joint is assembled.
f. Minimum thickness of bell rings shall be 3/16 inch. Bell rings shall conform to ASTM A570 Grade 30.

2. The modified bell and spigot type steel end ring shall be sized so that when installed into the pipe body, forty (40%) percent of the pipe wall thickness shall be between the inside face of the pipe joint and the centerline of the steel end ring.
3. Each ring shall be precisely sized by expansion beyond the elastic limit of the steel and then gauged on an accurate template.

a. All exposed surfaces of both rings shall be protected by a corrosion-resistant coating of zinc applied by an approved metalizing process after proper cleaning.
b. In addition to the zinc coating, the exposed metal surface shall be coated in the pipe shop with coatings similar and equal to Koppers 40 Passivator followed by two coats of Koppers No. 300 M coal tar epoxy, or approved equal to a total of 16 dry mil thickness.

c. The coating shall conform to the following requirements:
    1) Shall be firmly bonded to the steel joint rings.
    2) Shall be reasonably smooth and uniform.
    3) Shall show no separation between coats or layers.
    4) Shall be free from pinholes and blisters.
d. The application of all material comprising the coating system shall be in strict accordance with the recommendations of the particular manufacturer.
e. Particular attention shall be given to dry-out times, cure-out times, compatibility of primers and succeeding coats, weather conditions, and working conditions.
f. The coating shall completely protect the steel joint rings.
g. Steel end ring epoxy coating shall be applied to all pipe manufactured.

4. Joints shall be furnished with a flexible steel end ring protector on the exterior of the pipe similar and equal to Mar-Mac Flex-Protex joint filler as manufactured by Mar-Mac Manufacturing Company, Inc., McBee, South Carolina or a portland cement grout diaper joint protected by flexible sealant compound.
5. Interior joints of steel end ring shall be filled with an elastic pipe line joint filler.

    a. Joint filler material shall be product manufactured by one of the following:

        1) Sika Chemical Corporation.
        2) W. R. Meadows, Inc.
        3) Approved equivalent.
    b. Joint filler shall be applied to concrete surface free from "O" ring or gasket soap, scale, dirt, grease, etc.
    c. Joint gap shall receive, after thorough cleaning, one coat of primer along pipe bell and spigot ends.
    d. Joint opening shall be filled with backer rod to depth of ½ inch maximum or 1/4 inch minimum to the interior surface of the pipe.
    e. Caution: the proper depth of joint filler shall determine the bonding ability.
    f. Primer shall be allowed to dry to touch about 45 minutes before applying sealant.
    g. Sika-Flex 1A shall then be applied across joint opening between bell end and spigot end of pipe.

6. The Contractor shall apply joint sealant material during installation of the pipe joints to assure proper applications.

    a. Any joints that do not bond properly shall be removed and the above procedure shall be followed until proper joint has been built.
    b. Joint filler shall be installed upon completion of each days installation of pipe.
    c. Application of joint filler shall not be delayed more than twenty-four (24) hours after installation of pipe into the trench.
    d. Should the manufacturer of elastic pipe line joint filler as specified herein disagree with the above installation procedure he shall notify the Engineer in writing prior to joint material being applied.

7. Lubricants to be used in jointing pipes fitted with flexible, water-tight, rubber-type gaskets, either factory or job applied, shall be compatible with the material of the gaskets and as recommended by the manufacturer.

8. The material to be used as a primer or adhesive for jointing materials or for prefabricated gaskets shall be compatible with the material of the gasket or jointing materials.
9. Adhesives used to fasten flexible rubber or rubber type gaskets shall conform to the requirements of the manufacturer of the gaskets.

L. Joints (Bell and Spigot Type with O-ring).

1. Joints shall be bell and spigot type with rubber o-ring gaskets in accordance with ASTM C361 and ASTM C433.
2. Installed joint shall cause result in O-ring to being compressed on all four sides.
3. Lubricants used in joining pipes shall be compatible with gasket material and as recommended by the O-ring manufacturer.
4. If adhesives are used to fasten O-ring, they shall be compatible with gasket material and ad recommended by the O-ring manufacturer.

M. Workmanship and Finish.

1. Workmanship and finish of the pipe shall be first class in every respect.
2. Variations of the internal diameter of the pipe shall not exceed the following requirements:

    a. 3/8" for 36" and smaller pipe;
    b. 7/16" for 42" and 48";
    c. ½" for 54" - 78" pipe;
    d. 5/8" for 84" and larger pipe.

3. The planes of the ends of the pipe shall be perpendicular to the longitudinal axis of the pipe except as specified for beveled end pipe (special pieces below).
4. The ends of the pipe shall be of such a design that the pipe, when laid, shall form a continuous conduit with reasonably smooth and uniform interior surface.
5. The pipe shall be free from fractures, cracks, pits and surface roughness.
6. All form marks, ridges, aggregate protrusions, etc., shall be honed down or ground off to attain the desired surface finish.
7. All pits and depressions shall be filled with a permanent non-shrinking patching compound.
8. The mortar patching compound shall be one of the following:

    a. Embeco 167 Mortar as manufactured by Master Builders.
    b. Thoropatch as manufactured by Thoroseal Products.
    c. Approved equivalent.

9. Mortar shall be applied in accordance with the manufacturer's recommendations.
10. The Engineer shall inspect the lengths of pipe before they are shipped to the job site and shall require manufacturer to apply the mortar as directed.

N. Tests.

1. Tests for pipe manufactured in accordance to specifications for AWWA and ASTM shall be made in accordance with the requirements of ASTM Specification Serial

Designation C-76, latest revision to assist in determining the acceptability of the pipe furnished.

2. Standard test cylinders shall be made from concrete used in each day's production of pipe.

    a. Not less than two cylinders shall be prepared each day of production.
    b. Cylinders shall be broken at 7 days and at 28 days.

3. Three certified copies of all tests shall be furnished to the Engineer.

O. Special Pieces.

1. Special pieces of pipe such as bends, etc., shall conform to the following requirements:

    a. Shall be manufactured from cut lengths of straight pipe.
    b. Shall have carry-over reinforcement across joint planes of a design approved by the Engineer.

2. Special Pieces of pipe shall be manufactured such that the maximum allowable joint opening shall be 5/8" when the pipes are joined together in the trench to form the laying line in accordance with the laying schedule.

    a. The joint opening shall be such that with interior form line of pipe installed at the 12:00 o'clock position in the pipe trench the bevel (drop) shall occur at the 3:00 o'clock or 9:00 o'clock position as applicable.

3. Before beginning work on this project the Contractor shall submit to the Engineer a laying schedule for the pipe work to be performed.
4. The Contractor shall review the laying schedule with the pipe manufacturer for accuracy and constructability.
5. Should the Contractor or the pipe manufacturer determine any discrepancy in the laying schedule they shall notify the Engineer in writing.
6. Should corrections be required they shall be issued through job records and documents.
7. The Contractor shall adhere to the laying schedule unless exceptions are approved in writing by the Engineer.
8. The pipe laying schedule shall be prepared using limits for each of the type bends that are available.
9. Maximum tolerances for open joints shall be one-half (½) inch along the centerline of the pipe.

    a. Assumed tolerance for gain or loss in pipe joint stationing shall be based on past experiences with various construction projects.

10. The laying schedule is intended to provide guidance to the Contractor for the purpose of installing the pipe along a specified control line.
11. Maximum allowable deviations along centerline shall be one (1) foot either side of centerline.

12. Should deviations greater than one (1) foot occur, the Contractor shall adjust his laying technique or add required short lengths of pipe to maintain the installation within the specified tolerances herein.
13. The Contractor shall adhere to the laying schedule unless exceptions are approved by the Engineer in writing.
14. The Contractor shall submit to the Engineer his final version of the laying schedule prior to manufacturing pipe.
15. Review of the schedule by the Engineer does not relieve the Contractor of the responsibility for laying the pipe in accordance with details provided within acceptable limits.
16. Special pieces shall be manufactured in accordance with the laying schedule and as specified for joint openings.
17. The Contractor shall install all pipe with the form line at the 12:00 o'clock position in the pipe trench.

P. Special Design of Larger Pipe.

1. Special design of 48" and larger pipe shall be based on rational or empirical evaluation of the cracking behavior three edge bearing test (D-Load Test) of the pipe.
2. The design shall be verified by D-Load Test in accordance with ASTM C76, and to ultimate strength if less than 1.25 times the D-load.
3. The three edge bearing test to determine the load to produce a D-Load Test crack and also ultimate strength of the pipe shall be performed in the presence of the Engineer and the Owner for pipe manufactured in accordance with ASTM C76, performed upon award or contract to the lowest and best bidder, and performed on pipe aged to the minimum proposed by the pipe manufacturer for delivery to the job site.
4. The pipe manufacturer shall not manufacture reinforced concrete pipe, test pipe, or production pipe until approval has been obtained from the Engineer and the Owner in writing.
5. In stock pipe shall not be accepted.
6. The manufacturer of pipe in accordance to ASTM C76 Standards shall:

    a. Have a minimum of 1.75 inches of concrete cover over the inside steel cage and 1.0 inch of cover over the outside steel cage.
    b. Provide two complete circular mats of steel;
    c. Provide the strengths of steel as specified in Section 9.11 Part 2 of these Specifications.

7. Pipe shall be designed per applicable sections of ASTM Standards

    a. The pipe manufacturer shall be required upon receiving the order from the Contractor to submit to the Engineer for the Owner's and Engineer's review and approval, the design for the classes of pipe to be manufactured.
    b. The design shall include drawings to be submitted for stamped approval. The stamped approval drawings shall be furnished to the Engineer at the pipe manufacturer’s yard for use during the manufacturing of the pipe.
    c. Manufacturing drawings shall be required for each pipe size and pipe class.

d. The Drawings shall be working drawings to reflect sizes of steel (circumferential, longitudinal, spacer and stirrups steel) as well as steel placement.

8. The D-Load tests performed for verification of design shall be performed with the crown of the pipe rotated 4.5 inches from the 12:00 o'clock position.

    a. Should the verification test, after the lowest and best bidder has been designated, prove that the proposed pipe design is not acceptable due to failure of D-Load Testing procedure, the manufacturer shall modify the steel requirements to achieve acceptable D-Loads and shall test the modified design for acceptance as specified hereinabove at no cost to the Owner.

9. During production of accepted design of pipe, the Owner or his representative may select at random two full lengths joints of each class or size of pipe to be tested to D-Loads that would produce applicable (ASTM C76) crack.

    a. Test shall be in accordance with applicable sections of ASTM C 76 or as amended herein.
    b. Upon completion of said D-Load test procedures the joints of pipe tested that meet the applicable crack test shall be treated for the full length with epoxy coating as directed by the Engineer.
    c. The test shall be performed in the presence of the Owner and/or his representative.
    d. Payment for random selection, testing, and epoxy coating of pipe shall be in accordance with provisions of the Proposal Form and in accordance with these Specifications.
    e. Should the Owner or his representative select to test additional lengths of pipe, the Contractor shall be compensated in accordance with these Specifications.

10. The manufacturer shall provide a mark or form line to indicate the 12:00 o'clock position for the pipe that is manufactured.

    a. The location of the pipe crown (top most point) and the pipe invert (bottom most point 6:00 o'clock) shall be marked during manufacturing by welding a bead along the outside face of spigot, behind and adjacent to the gasket groove at the crown of the pipe while the steel cage is exposed for inspection.

11. The pipe manufacturer shall upon placing pipe on its side (horizontal length parallel to the earth) position the pipe such that the mark or form line shall be at the 12:00 o'clock position + or - 3 inches.

    a. No pipe shall be received onto the jobsite unless the mark or form line is in the 12:00 o'clock position + or - 3 inches.

Q. Acceptance of Pipe by Owner.

1. The Contractor shall not unload the pipe from trucks at the job site in a manner that might damage the pipe.

2. The method used to unload the pipe shall be subject to the approval of the Engineer.
3. It shall be the responsibility of the Contractor to assure that the pipe is manufactured, loaded, transported, unloaded, stored and installed in a manner which does not result in damage to the pipe.
4. Pipe sections shall be supported in at least three locations while in transit.
5. The Owner, in accepting the pipe to the job site, does not imply that the pipe is acceptable for its intended use.
6. The Owner or his authorized representative reserves the right to reject any and all pipe until it meets all the requirements of these Specifications.

R. Record of Pipe.

1. Record of pipe supplied for the project shall be furnished to the Owner or his authorized representative.
2. All pipe shipped to the job shall be clearly marked as to type, date of manufacture, and name or trademark or manufacturer.
3. The historical record of pipe supplied shall be in form approved by the Engineer and shall contain the following:

    a. Piece number of pipe
    b. Schedule number in line
    c. Class
    d. Date of manufacturer
    e. Dates of inspection
    f. Date of shipment
    g. Dates and results of compressive tests on cylinders and cores

2.3 REINFORCED CONCRETE DRAINAGE PIPE

A. Reinforced concrete drain pipe shall conform to the requirements of ASTM Specification C 76, latest revision.

B. Reinforced concrete drain pipe shall be Class III unless other Class is indicated.

C. Fittings for use with reinforced concrete drain pipe shall be equal to the requirements of ASTM C76.

D. In pipe furnished with tongue-and-groove ends, the joints shall be sealed with a flexible plastic gasket meeting the requirements of Federal Specifications SS-S-00210, Type 1, Rope Form and of AASHTO Designation M-198 75 1, Type B, Flexible Plastic Gasket (Bitumen).

1. The gasket shall be manufactured by one of the following:

    a. RAM-NEK Gasket Division of K. T. Snyder Company, Inc.
    b. Approved equivalent.

E. In pipe furnished with bell-and-spigot ends, the pipe shall be equipped with rubber O-ring seals fitted in recesses on the spigot ends of the pipe.

1. O-rings shall be solid rubber conforming to the requirements of ASTM C443.
2. Joints shall be made up in accordance with the recommendations and instructions of the manufacturer.

PART 3 - EXECUTION

3.1 JOINING OF PIPE

A. Pipe joining procedure shall be in accordance with these Specifications and in accordance with the recommendations of the manufacturer of the particular type of joint.

B. Tongue-and Groove Pipe.

1. The joint surfaces shall be thoroughly cleaned
2. The annular space shall then be completely filled with a plastic joining material similar and equal to Ram-Nek.

C. O-Ring Joint.

1. All joint surfaces and gasket recesses shall be thoroughly cleaned.
2. The gaskets shall be first thoroughly cleaned and then lubricated.

3.2 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual" Using mortared tongue and groove joints. If gaskets or seals are indicated, they shall conform to the following:

1. Round Pipe and Fittings: ASTM C 443, rubber gaskets.
2. Elliptical Pipe: ASTM C 877, Type I, sealing bands.
3. Arch Pipe: ASTM C 877, Type I, sealing bands.

B. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

END OF SECTION 33 41 14

SECTION 33 41 16 - PLASTIC PIPE AND FITTINGS FOR STORM DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for Plastic pipe and fittings including the following:

1. Plastic pipe and fittings
2. Fiberglass pipe and fittings
3. Cleanouts

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. B. Shop Drawings: Include the following.

1. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Power and control wiring diagrams, including terminals and numbers.
4. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
5. Factory finish system.

1.4 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall provide the proper equipment, tools and facilities necessary for the efficient prosecution of the work.

1. Materials damaged in unloading, handling or installation shall be promptly discarded and removed from the area of the work.
2. No pipe shall be unloaded or moved by allowing the pipe to roll, slide or fall to the ground or to cushions placed on the ground.
3. No pipe, fittings, valves, etc., shall be unloaded by inserting loader blades, teeth, etc., into the pipe interior.

B. Pipe shall be stored on racks or timbers in such a manner that pipe ends are above the ground surface.

1. When pipe is to be moved it shall not be dragged or rolled but shall be lifted by use of a sling designed to prevent damage to the pipe coatings.
2. Should an intermediate placement of the pipe along the side of the trench be required, the pipe shall be placed on racks or timbers along the side of the trench in manner as specified hereinabove.

C. Each length or section of pipe shall be cleaned immediately before being placed in the trench and joined.

1. Cleaning shall be accomplished by use of a tight swab or other suitable cleaning device.
2. If necessary a brush pig shall be run through the section of pipe prior to final swabbing.
3. Pipe ends shall be wiped clean before the pipe is joined.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL AND FITTINGS

A. The contractor shall carefully examine all pipe and piping materials before placing them in the work. If any such pipe or materials should be found to be defective, the Contractor shall promptly notify the Engineer and discard such pipe and materials.

B. The interior of all pipe, fittings, valves and accessories shall be kept free from dirt and foreign material.

1. Suitable bulkheads shall be used to block or plug ends of piping at the close of each work day and when work on a particular section of piping is temporarily discontinued.
2. Should dirt, mud, concrete, latence, paint or other foreign materials be allowed to enter the piping or any section of piping, such piping or section of piping shall immediately be cleaned.

C. Piping materials shall be of the types, classes and sizes shown or as specified in the piping schedule.

2.2 PLASTIC PIPE AND FITTINGS

A. General Service

1. Plastic pipe shall be of types as hereinafter specified or as shown on the Drawings.
2. The particular Type, Grade and Schedule of pipe used for a particular installation shall be suitable for the service intended.
3. PVC pipe shall be manufactured from rigid polyvinylchloride compounds meeting the requirements of ASTM D1784, latest revision, Class 12454-B.
4. Pipe shall meet requirements of ASTM D1785 latest revision Type 1.
5. Pipe shall be Schedule 80 unless otherwise indicated, and shall be furnished with threaded ends suitable for connection to fittings, companion flanges, and flanged valves.
6. Fittings shall meet the requirements of ASTM D2464, latest revision.
7. All pipe, fittings and valves shall be manufactured from molding compounds

meeting the requirements of ASTM D1784, latest revision, Class 12454-B as specified hereinabove so as to ensure compatibility of materials.

8. Materials from which pipe, fittings and valves are manufactured shall have been tested and approved by the National Sanitation Foundation and shall be suitable for service associated with the production of potable water.
9. PVDF pipe shall be manufactured from natural polyvinylidene fluoride compound meeting the requirements of ASTM D3222, latest revision, and having a minimum tensile strength of 7100 psi at 73^{o}F when tested in accordance with ASTM D638, latest revision.
10. Pipe shall have nominal pipe sizes and wall thicknesses as given for Schedule 80 pipe in Table 2 of ASTM D1785, latest revision, unless otherwise indicated.
11. Fittings may be either socket fusion type meeting the requirements of ASTM D2657, latest revision, or threaded type having dimensions and tolerances in accordance with ASTM D2464, latest revision, according to the manufacturer's recommendations.
12. If the socket fusion type method of joining the pipe should be used, disassembly of pipe shall be provided for at changes of direction of pipe and at valves by use of companion flanges or threaded couplings or other means as recommended by the manufacturer.
13. All pipe, fittings and valves shall be manufactured from molding compounds meeting the requirements of ASTM D3222, latest revision, as specified hereinabove so as to ensure compatibility of materials, and all materials (including joining materials) shall be suitable for service associated with the production of potable water.
14. Magnetic locator tape shall be provided for all plastic piping installed underground.

B. Gravity Service

1. PVC gravity sewer pipe shall conform in all respects to Standard Specifications for Type PSM Polyvinylchloride (PVC) Sewer Pipe and Fittings ASTM D 3034, latest revision, (sizes 4" - 15"); ASTM F679, latest revision, (sizes 18" - 27"); covering requirements and test methods for materials, dimensions, workmanship, flattening resistance, impact resistance, pipe stiffness, extrusion quality, joining systems and a form of marking.
2. Pipe conforming to ASTM D3034, latest revision, shall have a minimum wall thickness of SDR 35.
3. Pipe conforming to ASTM F679, latest revision, shall have a minimum pipe stiffness (PS) of 46 psi and minimum T-1 wall.
4. Pipe shall be furnished in sections not less than ten (10) feet in length and not greater than thirteen (13) feet in length.
5. Pipe and fittings shall be inspected and tested in accordance with ASTM D 3034 or ASTM F679, latest revisions, by a testing laboratory acceptable to the Owner and certified copies of the test reports and test results shall be furnished to the Owner.
6. Pipe and fittings shall be clearly marked in accordance with Section 12 of ASTM D 3034, or Section 11 of ASTM F679.
7. Pipe shall be furnished with bell and spigot end with elastomeric seals.
8. Spigot (plain) ends shall be marked to indicate when a "full-home" position of spigot in bell has been attained.
9. Seal rings or gaskets shall be continuous elastomeric rings meeting the requirements of ASTM D 3212, latest revision.

10. Material for seal ring shall be specifically formulated for wastewater service.
11. The joints shall meet all test requirements of ASTM D 3212, latest revision, and certificates of compliance shall be furnished to the Owner

2.3 FIBERGLASS PIPE AND FITTINGS

A. RTRP (Fiberglass Pipe) shall conform to the following requirements:

1. AWWA C950.
2. Shall be [Class 150] [Class 200] [and] [Class 250].
3. Shall be Type I[or II].
4. Shall be [Grade 1, epoxy] [or] [Grade 2, polyester].
5. Shall have bell-and-spigot ends [for bonded] [with gasket or seal for gasketed] joints.
6. Liner is optional unless indicated.[Include FM approval if used for fire-service mains.

B. RTRF (Fiberglass Fittings) shall conform to the following requirements:

1. AWWA C950
2. Shall be similar to pipe in material, pressure class, and joining method.

C. Fiberglass pipe (UL RTRP) shall conform to the following requirements:

1. UL 1713.
2. Shall be [Class 150] [and] [Class 200] [and] [Class 250].
3. Shall have bell-and-spigot ends with gasket or seal for gasketed joints
4. Liner is optional unless indicated.

D. Fittings shall be similar to pipe in material, pressure class, and joining method.

2.4 CLEANOUTS

A. PVC Cleanouts shall conform to the following requirements:

1. Shall have a PVC body with PVC threaded plug.
2. Shall include PVC sewer pipe fitting and riser to clean out of same material as sewer piping or proper adapters.

PART 3 - EXECUTION

3.1 JOINING OF PIPE

A. Pipe joining procedure shall be in accordance with these Specifications and in accordance with the recommendations of the manufacturer of the particular type of joint.

B. Push-On Joint Pipe

1. The joining of Push-On Joint pipe shall be performed in accordance with the AWWA Standard for Underground Installation of PVC Pressure Pipe and Fittings

for Water, C606 and in accordance with the manufacturer's instructions and/or recommendations for the particular joint furnished.

2. The inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating and other foreign matter.
3. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the socket.
4. A thin coat of gasket lubricant shall be applied to either the inside surface of the gasket or outside surface of the spigot, or both.
5. Gasket lubricant shall be as supplied by the particular manufacturer and reviewed by the Engineer.
6. The spigot end of the pipe shall be carefully inserted in the socket so that the joining surfaces will not come in contact with the ground, trench bed or trench sides.
7. The joint shall then be completed by forcing the spigot end to the bottom of socket by methods as recommended by the particular manufacturer and concurred with by the Engineer.
8. All pipe shall be furnished with a depth mark to indicate a 'full-home' assembly.
9. The Contractor shall provide special transition sleeves or transition pieces of pipe for connecting pipe of different classes; and those special pieces shall be clearly identified with suitable marking.
10. If the Contractor desires to cut lengths in the field to make closures, he shall have on hand an adequate number of lengths of pipe of the various classes having the exterior of the barrel gauged to fit the socket of pipe.

C. Polyethylene Pipe

1. Heat Fusion Joining

   a. Butt, socket, and saddle fusion joints in polyethylene gas pipe shall be made using procedures that have been qualified and approved by the Federal Department of Transportation (DOT) in accordance with CFR, Title 49, Part 192.283.
   b. The Contractor shall ensure that all persons making heat fusion joints have been qualified to make joints in accordance the above referenced CFR code.
   c. The contractor shall maintain records of qualified personnel, and shall certify that qualified training was received not more than twelve (12) months prior to commencing work.

2. Butt Fusion of Unlike Wall Thicknesses

   a. Butt fusion shall be performed between pipe ends, or pipe ends and fitting outlets that have the same outside diameter and are not different in wall thickness by more than one (1) standard DR (i.e. SDR 9 to SDR 11).
   b. Transitions between unlike wall thicknesses greater than one (1) DR shall be made with a transition nipple or by mechanical means.

3. Mechanical Compression Couplings

   a. Polyethylene gas pipe and fittings may be joined together to other materials by transition fittings or fully restrained mechanical couplings. These devices

shall be designed for joining polyethylene gas piping to another material and shall be approved by the DOT.

b. When mechanical couplings are used for joining, polyethylene gas piping shall be reinforced with a stiffener in the pipe bore. Stiffeners shall be properly sized for the diameter and wall thickness of the polyethylene gas piping being joined.

c. For service connections, the stiffener length shall match the pipe end penetration depth into the coupling.

3.2 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. PVC Sewer Pipe and Fittings shall be as follows:

1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
2. Install according to ASTM D 2321.

3.3 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade.

1. Use PVC sewer pipe fittings in sewer pipes at branches for cleanouts and PVC sewer pipe for riser extensions to cleanouts.
2. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers located in unpaved areas in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding finished grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

END OF SECTION 33 41 16

SECTION 33 41 18 – TEMPORARY BY-PASS PUMPING AND PIPING

PART 1 - GENERAL

3.1 SUMMARY

A. The Contractor shall design, furnish and install all materials, labor, supervision, maintenance, equipment, fuel, fuel storage, etc. required to implement temporary by-pass pumping and piping for the purpose of diverting existing wastewater flows around portions of the work area for the entire duration of the project, or portions thereof, when his activities interfere with normal functioning of the treatment system and associated facilities in any way. Temporary by-pass pumping shall not disrupt or interfere with WWTP processes/operations.

B. The design, installation, and operation of each temporary by-pass pumping and piping systems shall be the Contractor's responsibility throughout the duration of the project.

C. The by-pass systems shall meet the requirements of all local, state, and/or federal codes and regulatory agencies having jurisdiction.

D. The Contractor shall be solely responsible for any spills/discharges/leaks associated with the Work, including clean-up costs, fines, or other costs incurred. The Contractor will not receive extra Contract Time for delays caused by improper equipment, labor, or breakdowns.

3.2 BY-PASS PUMPING PLANS: The Contractor shall develop and submit to the Engineer/Owner a by-pass pumping plan(s) for review and approval. The plan(s) shall include drawings/sketches and descriptions outlining all provisions and precautions to be taken. It shall also include schedules, capacities of equipment and materials, provisions for pipe supports, bracing/thrust restraint, noise considerations, standby capacity/provisions, monitoring and maintenance considerations.

PART 2 -- PRODUCTS

2.1 BY-PASS PUMPS AND PIPING

A. The Contractor shall provide any and all temporary utilities and services required for operation of the by-pass pumping equipment, shall maintain these utilities and services during the Contract period, and shall remove them upon completion of the Work.

B. Pumps shall be fully-automatic, self-priming units that do not require the use of foot valves, vacuum pumps, or diaphragm pumps in the priming system unless otherwise approved by the Engineer.

C. The duty pump(s) and the backup pump(s) shall be diesel-powered unless otherwise approved by the Engineer.

1. Contractor shall be responsible for providing and storing a sufficient quantity of diesel fuel on-site to operate the duty pump(s) for a minimum of 24 hours at all times during performance of the Work.

2. Contractor shall check the level in the diesel fuel tank(s) and shall re-fill the tank(s) to full capacity on a daily basis.
3. All pumps used shall be constructed to allow dry running for long periods of time to accommodate the cyclical nature of the flows.

D. The Contractor shall provide all pipeline plugs, pumps of adequate size to handle peak flow, and temporary discharge piping to ensure that the total flow for the specific sanitary sewer pipe to be by-passed can be safely diverted around the work area while the sanitary sewer piping/facilities are being modified. No leakage from valves, piping, and connections will be allowed during operation.

E. Discharge piping shall be constructed of ductile iron, polyethylene, or Acrylonitrile-Butadiene-Styrene (ABS) pipe with positive, restrained joints. All pipe materials utilized in temporary by-pass pumping during construction shall be in good condition and shall be free of defects and leaks; any defective material shall be replaced by the Contractor at no cost to the Owner and Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor shall be responsible for locating all existing utilities in the area where the Contractor selects to locate the by-pass pumps and pipelines, including locating the Owner's existing discharge force main, if applicable, for connection to the by-pass piping. The Contractor shall locate his by-pass pipelines to minimize any disturbance to existing facilities and operations and shall obtain approval of the pipeline locations from the Owner and/or Engineer.

B. During all by-pass pumping operations, the Contractor shall protect the by-pass pumps, by-pass pipelines, discharge pipeline or structure, and influent pipeline or structure from damage inflicted by any equipment. The Contractor shall be responsible for all physical damage to the temporary pumping system or treatment processes structures or equipment caused by human or mechanical failure.

C. Contractor shall keep spare parts for pumps and piping on-site as required. Contractor shall maintain adequate hoisting equipment for each pump and accessories on-site.

3.2 INSTALLATION AND REMOVAL

A. The Contractor shall pipe sections or make connections to the existing pipelines or structures and construct temporary by-pass pumping structures only at the access location and as may be required to provide an adequate suction conduit.

B. Each temporary by-pass pumping system shall be tested before placing the system in operation.

C. The temporary influent force main piping shall be designed, constructed, and maintained with the piping and valves necessary to enable flow to be directed to either the existing headworks and/or the new headworks, thus providing flexibility needed during construction and start-up of the new facilities. The temporary system shall remain operational/in place until such time as the new

facilities have been tested and approved for use by the Owner and regulatory officials.

D. At the conclusion of a specific by-pass pumping operation and when all of the modifications or improvements to the specific treatment process are complete, tested, and ready for operation, Contractor shall demonstrate the new equipment or system for a duration of time as approved by the Owner and/or Engineer.

END OF SECTION 33 41 18

SECTION 44 42 13 – BIOLOGICAL NUTRIENT REMOVAL SYSTEM

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 equipment specified in this section has been pre-selected by the Owner through a request for proposal (RFP) process. The specifications that follow are the basis for contractors to prepare construction bids for this pre-selected equipment. the pre-selected manufacturer's proposal can be found in **Appendix B** of these specifications.

B. The Manufacturer shall provide single-source responsibility for the complete biological nutrient removal (BNR) system, including equipment, controls, programming and startup, and training.

C. The intent of this specification is to outline the requirements for the aeration, mixing, and controls required for biological nutrient removal in the existing aeration basin and in the new aeration basin. The basins will be operated in parallel, and thus, will provide operational redundancy.

D. Existing Aeration Basin: It is generally desired to optimize treatment capacity and efficiency while implementing BNR in the existing aeration basin by installing fine bubble aeration and separate/supplemental mixing.

E. New Aeration Basin: It is also generally desired for the new aeration basin to be slightly larger than the existing aeration basin, and to optimize treatment capacity and efficiency while implementing BNR with fine bubble aeration and separate/supplemental mixing in the anaerobic zone.

F. The scope of supply shall include the following components at a minimum:

1. Fine bubble aeration system
2. Electrically modulated control valves
3. Submersible mixers
4. System control panel
5. Instrumentation

G. Manufacturer: This specification is written around the pre-selected Xylem/Sanitaire Casperon Process.

H. The Manufacturer shall provide single-source responsibility for the complete biological nutrient removal (BNR) system, including equipment, controls, programming, and startup and training.

I. The Manufacturer shall have in-house electrical engineers experienced with municipal and industrial control systems and system integration, and that are responsible for programming and commissioning the control panel.

J. The Manufacturer shall have in-house process engineers experienced with municipal activated sludge processes and that are responsible for process training and commissioning support.

K. The Manufacturer shall provide installation and startup assistance training and guarantee the process performance as specified herein.

L. It is the intent of these specifications that a single manufacturer-supplier, regularly engaged in the design, manufacture, assembly, and production of biological processes and controls of the type specified shall have complete responsibility for the final design, furnishing, coordination, assembly, and installation supervision of all components in the biological process.

M. Detailed drawings, including arrangement and erection drawings of the equipment and control equipment; schematic control diagrams, electrical connection diagrams, and complete description of the control systems; and equipment operating characteristics shall all be furnished by the Manufacturer.

1.3 SUBMITTALS

A. The Contractor shall provide system submittals as follows:

1. Submit required copies of Manufacturer's literature, dimensional drawings, wiring diagrams, motor data, performance data, materials of construction, a description of the process design (Operational Description), a description of the control system software logic (Functional Design Specification), Alarm and I/O List, and any other information necessary to determine compliance of the equipment to the specification and project requirements.
2. Highlight project-specific model numbers and options in equipment data sheets.
3. Submittal drawings showing plan, elevation and cross sections of the equipment.
4. Component details of the aeration equipment showing diffusers, diffuser holders, gaskets, retainer rings, supports, threaded union and/or flanged joints, and a purge system.
5. Materials and Manufacturing specifications.
6. Aeration System submittal information to include:

    a. Equipment data sheets
    b. Performance data including oxygen transfer calculations
    c. Certified SOTE curves from previous test runs on equivalent system shop transfer testing.
    d. Headloss calculations and pressure requirements.
    e. Customer contact list with telephone numbers (minimum of 10 contacts from similar size facilities).

B. Operation and maintenance manual with installation instructions. Submit after approval of equipment and prior to shipment.

C. Process Performance Guarantee

D. Additional submittal requirements in accordance with Specification Section 01 33 00.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be delivered in unopened, undamaged crates designed for handling and storage.

B. Equipment shall be stored and protected in accordance with the Manufacturer's recommendations.

PART 2 - PROCESS DESCRIPTION

2.1 SYSTEM DESCRIPTION

A. The system shall incorporate activated sludge treatment and shall include zones for anoxic and/or anaerobic treatment as required for the necessary BOD, ammonia and nutrient removal.

B. Related equipment, which is not in the scope of supply of the pre-selected Xylem/Sanitaire Casperon Process includes secondary clarifiers for solid-liquid separation, with a RAS pump system to return a controlled amount of sludge for operation of the activated sludge process, and tertiary cloth filters will provide polishing and additional solids removal.

C. In the two inner rings of the existing oxidation ditch, the functions of aeration and mixing shall be independent and shall not be provided by a single piece of equipment.

2.2 INFLUENT CHARACTERISTICS AND EFFLUENT REQUIREMENTS

A. Influent Wastewater Characteristics are shown in Table 1 below:

Table 1: Basis of Design for BNR System
Shenandoah WWTP – Coweta County (Newnan), Georgia

Influent Wastewater Characteristics	
WWTP influent design flow, monthly average	6 MGD
WWTP influent design flow, peak hourly	12 MGD
Influent BOD_5, monthly average	15,021 lb/day (300 mg/l)
Influent TSS, monthly average	15,021 lb/day (300 mg/l)
Influent TKN, monthly average	3,500 lb/day (70 mg/l)
Influent Ammonia, monthly average	1,500 lb/day (30 mg/l)
Influent TP, monthly average	600 lb/day (12 mg/l)
Temperature range (water)	12 – 25 °C
Temperature range (air)	20 – 90 °F
Site elevation	810 ft above MSL (approximate)

2.3 EFFLUENT REQUIREMENTS

A. The minimum effluent requirements are per the Manufacturer's written process/performance guarantee included in the **Appendix B** of the specifications.

PART 3 - SYSTEM EQUIPMENT

3.1 MODULATING CONTROL VALVES

A. The Manufacturer shall furnish the following motor-operated butterfly valves to control independent aeration grids in the aerated tanks/zones. The valves shall be supplied with an electric actuator, compartment heaters, and handwheel for manual operation. I/O provisions for each actuator shall be as required by the point lists on electrical plans. See sections 22 05 23 and 22 05 23.10 for additional requirements.

Valve Location	Existing Aeration Basin No. 1	New Aeration Basin No. 2
Valve Quantity	4	4
Valve Diameter	6 inches	6 inches
Actuator Power Supply	480V/3Phase/ 60Hz	480V/3Phase/ 60Hz
Actuator Type	Modulating	Modulating

3.2 FINE BUBBLE AERATION

A. Furnish all materials, equipment, services, and testing for the fine bubble aeration system. Provide the components listed below at a minimum:

1. Stainless steel drop legs, supports, and anchors.
2. PVC manifolds, air distributors, diffuser holders, and retainer rings
3. Bolts, nuts and gaskets for aeration system flange connections.
4. Air distributor purge systems.
5. Membrane disc diffusers with integral O-ring gaskets.

B. System Design and Performance

1. Design aeration oxygen transfer shall be at 14.7 PSI, 20°C and zero dissolved oxygen at the specified submergence, air rate and pressure.
2. Design air distributors with centerline spacing not to exceed 4 feet to maximize oxygen transfer efficiency and mixing efficiency and to minimize solids deposition between air distributors. Supplemental (submersible) mixing is required in the existing aeration basin.

C. Materials Fabrication and Finishing

1. Stainless Steel – Pipe, Fittings and Supports

a. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless steel with a 2D finish conforming to ASTM A240, 554, 774, 778.
b. Fabricate non-welded parts and flanges from sheets, plates or bars of 304 stainless steel conforming to ASTM A240 or ASTM A276.

c. Welds & Welding Procedure

1) Weld in the factory using latest standards according to AWS. Continuously weld both sides of face rings and flanges to eliminate potential for crevice corrosion.
2) Corrosion Protection and Finishing: Clean all welded stainless steel surfaces and welds after fabrication. Preclean outside and finish clean all interior and exterior welds and piping by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3.

2. Natural Rubber – Furnish all fixed and expansion joint O-ring gaskets of natural rubber/SBR with a Shore A durometer of 45 ± 5.

3. Polyvinyl Chloride (PVC) – Pipe and Fittings

a. Produce all PVC pipe and fittings from PVC compound with a minimum tensile strength of 7000 psi.
b. Provide lower drop pipe, manifold and air distributors as follows:

Diameter	Wall Thickness	ASTM
4 inch	SDR 33.5	D3915, 3034
5 inch & larger	Schedule 40	D1784, 1785, 2466

c. Factory solvent weld all PVC joints. Field solvent welding will NOT be permitted.

4. EPDM - Membrane Diffusers and Gaskets

a. Manufacture circular membrane diffuser discs with integral O-ring of EPDM synthetic rubber compound with precision die formed slits. Thermoplastic materials (i.e. plasticized PVC or polyurethane) are not acceptable.
b. Add carbon black to the material for resistance to ultraviolet light.
c. Design diffuser as one piece injection molded part with a minimum thickness of 9-inch diameter unit. Compression molded diffuser elements are not acceptable.
d. Limit the maximum tensile strength of the diffuser to 10 psi when operating at 2.4 SCFM/ft² of material. Furnish proportionately thicker material for larger diameter disc diffusers to limit the maximum tensile stress and to resist stretching.
e. Produce diffusers free of tears, voids, bubbles, creases or other structural defects.
f. Furnish diffuser material to meet the following:

Item	**Value/Units**	**ASTM**
Base Polymer	EPDM	D573
UV Resistance	Carbon Black	
Specific Gravity	1.25 or less	

Durometer – Minimum	58% ± 5%	D2240
Modulus of Elasticity	500 psi	D412
Ozone Resistance (72 hrs: 40°C pphm)	No cracks @ 2X magnification	D1171 Test A
Tensile Strength	1200 psi	D412
Elongation - % - Retained 70 hrs @ 100°C - minimum at break	 75% Max 350%	 D573 D412

g. Quality Control – Test diffuser using primary sampling criteria outlined in Military Standard 105E.
h. Membrane Longevity
i. Longevity of the proposed membrane diffusers shall have been demonstrated in at least three (3) full-scale municipal installations operating continuously for a period of three (3) years.
j. Test reports, prepared by an independent testing agency, shall confirm membrane longevity through compliance with the following maximum allowed percent (+/-) change in each membrane property. Tests conducted in-house by the Manufacturer shall not be acceptable.
k. Data for a minimum of three diffusers from each installation shall be provided.

Property	Maximum Change
Durometer	5%
Weight	5%
Permanent Set	0.5%

l. Test reports shall be submitted with the equipment submittals.

D. Fine Bubble Aeration System Components: Each grid will consist of the following components:

1. Dropleg - Provide a stainless steel dropleg from the air main connection to the dropleg connection above the manifold.

a. Provide a Van Stone style flange with a 150 pound bolt pattern for the top connection.
b. Provide a band clamp coupling with gasket for the lower dropleg to manifold
c. Provide a Van Stone style flange with a 150 pound bolt pattern for the top connection.
d. Provide a band clamp coupling with gasket for the lower dropleg to manifold.

2. Manifold – Provide a PVC manifold for connection to the air distribution headers.

a. Provide a band clamp coupling with gasket for the lower dropleg to manifold.
b. Outlets shall be provided along the bottom centerline of the manifold.
c. Fabricate manifolds with 4 inch diameter fixed threaded union or flanged joints for connection to the air distributors.

d. Design manifold, distributor connections and supports to resist thrust generated by expansion/contraction of the air distributors over a temperature range of 125° F
e. Support manifold with a minimum of two supports.
f. Connect manifolds with fixed threaded union or flanged joints to prevent rotation or blow apart.
g. Manifolds shall be raised to allow for interlacing two separate grids of air distribution headers per tank.

3. Air Distributors and Diffuser Holders - Provide 4 inch diameter air distributors perpendicular to the air manifold.

a. Fabricate distributors with single diffuser holders solvent welded to the crown of the air distributor for complete air seal and strength.
b. Provide minimum solvent weld area of 15 square inches.
c. Design distributors and holders to resist a dead load of 200 lbs applied vertically to the outer edge of the diffuser holder.
d. Provide 4 inch diameter threaded removable end caps complete with gasket, threaded coupling and end plate for clean out at the end of each distributor.

4. Air Distributor and Manifold Connection Joints

a. Join air distributor sections with positive locking fixed threaded union or flange type joints for all submerged header joints to prevent blow apart and rotation.
b. Bell and spigot, slip on or expansion type joints are not acceptable for submerged joints.
c. Design threaded union joints with spigot section connected to one end of the distribution header, an O-ring gasket and a threaded screw on retainer ring. Solvent welding shall be done in the factory.

5. Supports - Provide each section of manifold and air distributor with a minimum of two (2) supports.

a. Limit maximum support spacing to 8 feet.
b. Design all supports to allow for thermal expansion and contraction forces over a temperature range of 125° F and to minimize stress build up in the piping system.
c. Design supports to be adjustable without removing the air distributor from the support.
d. Manifold Support – 6 inch diameter and larger.

1) Design supports to include hold down guide straps, support structure and anchor bolts.
2) Design guide straps with a 2 inch minimum width to eliminate point load on manifold and minimize binding.
3) Design support for 2 inches plus or minus vertical adjustment for leveling of manifold.

4) Air Distributor and Manifold Supports – 4 inch diameter.
5) Design supports with hold down straps, support structure and anchor bolt.
6) Design support for 1 1/2 inch(plus or minus) vertical adjustment for leveling air distributor to plus or minus 1/4 inch.

e. Guide support

1) Guide straps to have 1 1/2 inch wide top and bottom contoured bearing surface with chamfered edges to minimize binding and resistance to movement of air distributor under full buoyant uplift load.
2) Design strap with 1/8 inch clearance around distributor so strap is self-limiting and cannot be over tightened.

f. Fixed supports

1) Fixed straps to have 1 1/2 inch wide top and bottom contoured bearing surface with punched burrs to positively grip the air distributor when tightened.
2) Design strap to be self-limiting to prevent stressing the distributor if the clamp is over tightened.
3) Attach supports to tank floor with one stainless steel anchor bolt.

6. Diffuser Assemblies Furnish diffuser assemblies including diffuser, diffuser gasket, holder, retaining ring and air flow control orifice.

a. Membrane Diffuser

1) Incorporate an integral check valve into the membrane diffuser.
2) Design and test aeration diffusers for a dynamic wet pressure (DWP) of 12 inches $\pm$ 20% water column @ 1.0 SCFM/diffuser and 2 inches submergence in the Aeration Tanks.
3) Visual Uniformity – Observe diffusers for uniform air distribution across the active surface of the diffuser at 1.0 SCFM- 1.5 SCFM/diffuser and 2 inches submergence. Active surface is defined as the perforated horizontal projected area of the diffuser.
4) Quality Control – Test diffuser using primary sampling criteria outlined in Military Standard 105E.
5) Diffuser Support Plate – Provide a PVC support plate to form an air plenum under the diffuser and support for the membrane when the air is off.

b. Diffuser Holders and Retainer Rings

1) Design holder to provide peripheral support for the diffuser.
2) Design holder with air flow control orifice below the diffuser.
3) Design retainer ring to seal the diffuser and o-ring in the holder to prevent air leakage around gasket.
4) Design retainer ring threads with minimum cross-section of 1/8 inch and allow for one complete turn to engage threads.

7. Anchor Bolts

    a. Provide a mechanical 304 SS expansion anchor bolts for embedment in 4,000 psi concrete with a pullout safety factor of 4.

8. Liquid Purge System

    a. Provide a continuous purge assembly for each air distribution header.

3.3 SUBMERSIBLE MIXERS

A. The equipment specified herein shall be located as shown or described and installed in conformance with the Manufacturer's suggested method as approved by the Engineer.

B. Submersible mixers shall be Xylem/Flygt submersible type as defined in the table below.

C. The mixer shall be of the close-coupled, submersible type. The mixers for the installation in the two inner channels of the existing ditch shall be gear driven.

D. All components of the mixer, including the motor and gearbox, shall be capable of continuous underwater operation while the mixer blades are completely submerged.

E. The mixer shall be capable of handling raw, screened sewage.

F. The mixer shall be designed to be raised, lowered, and removed for inspection or service without the need for personnel to enter the tank.

G. A sliding guide bracket shall be an integral part of the mixer unit.

H. The entire weight of the mixing unit shall be guided by the guide bracket, which shall be able to handle all thrust created by the mixer.

I. The mixer, with its appurtenances and cable, shall be capable of continuous submergence underwater, without loss of watertight integrity, to the depth indicated.

J. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings.

1. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces, resulting in compression of the O-rings without requiring a specific torque limit.
2. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease, or other devices shall be used.

K. Leakage Sensors will be provided for sensing the presence of water in the oil and/or stator housing.

1. Sensor is to be connected to a Mini CAS monitoring unit.
2. Mini CAS unit is to monitor the current allowable flow form both the temperature switches and leakage sensor.

L. Cable Entry (Direct Drive Mixers)

1. The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of a cable entry failure. Single sealing systems will not be deemed acceptable. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak proof seal at the cable entrance without the need for specific torque requirements. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the mixer top. Connection shall be made between the threaded compressed type binder posts thus securely affixing the cable wires to the terminal board. The use of the terminal compressed type post and a terminal board O-ring shall render the motor compartment leak proof from any liquid which may enter the terminal compartment.

M. Cable Entry (Gear Driven Mixers):

1. The cable entry shall be an integral part of the stator casing.
2. The cable entry shall be composed of a single cylindrical elastomer grommet, flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak proof, torque free seal at the cable entrance.
3. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a brass gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion.
4. Sealing shall be accomplished by metal-to-metal contact between machined surfaces resulting in compression of the O-ring. Epoxies, silicones, or other secondary sealing systems shall not be considered.
5. No terminal board in the motor is required.

N. Motor (Non-explosion proof)

1. Direct Driven Mixers: The multi-pole motor shall be directly connected to the propeller (gearbox designs are not acceptable). The mixer motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The motor shall be designed for continuous duty, capable of no less than 30 evenly spaced starts per hours. The rotor bars and short circuit rings shall be made of aluminum. Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three (3) thermal

switches embedded in the end coils of the stator winding and set for 284°F (140°C). These shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

2. Gear Driven Mixers: The mixer motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.The use of multiple step dip and bake-type stator insulation process is not acceptable. The motor shall be designed for continuous duty, capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. The motor shaft, delivered with the rotor as an integral part, shall be stainless steel. Thermal sensors, embedded in the stator winding end-turns and wired into the pump control, shall be used to monitor motor over-temperature. These shall be supplemental to the external motor overload protection located in the control panel.

O. Motor Data

SUBMERSIBLE MIXER MOTOR DATA		
Mixer Location	Anaerobic Zones	Inner channels of ditch
Mixer Type	Direct Drive	Gear Driven
Rated Shaft Power	4.0 Hp	6.2 Hp
Mains frequency	60 Hz	60 Hz
Number of Phases	3	3
Rated Voltage	460-480	460-480
Number of Poles	10	10
Max. input Power	5.2 Hp	7.3 Hp
Rated Temperature	40 °C / 104 °F	40 °C / 104 °F

P. Mechanical Seals

1. Direct Driven Mixers: The standard inner mechanical seal is corrosion resistant Tungsten Carbide/Aluminum Oxide. The outer seal faces are Tungsten Carbide/Tungsten Carbide. One face of the inner seal ring pair shall have spiral grooves laser etched in it, to provide a pumping action to move leakage from the stator housing back into the oil chamber. In order to avoid seal failure due to sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the oil housing. The mixer shall be equipped with a seal shield that prevents fibrous material from winding up around the shaft and outer seal. The shield shall be welded to the propeller hub and extend towards the motor. The shield shall rotate with the propeller and there shall be a radial micro-gap between the shield and oil-housing.
2. Gear Driven Mixers: Each mixer shall be provided with three seals to separate the various parts of the mixer. The outer seal on the propeller shaft shall be a lapped end face type mechanical seal containing one stationary and one positively driven rotating, corrosion resistant, tungsten carbide face ring running in the mixed media for cooling and lubrication. All seal face surfaces must be capable of re-lapping. In order to

prevent seal spring jamming and failure, the seal spring shall not be exposed to the mixed media. The inner seal on the propeller shaft shall be a nitrile rubber, lip seal isolating the propeller shaft oil chamber from the gearbox oil chamber. The third seal shall be a fluorinated rubber, lip seal mounted on the motor shaft to isolate the gearbox oil chamber from the dry motor stator housing.

Q. Oil Housing

1. Direct Driven Mixers: The oil housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate oil flow. In the event that the mixed media bypasses the other seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of a simple gravity process. Mixers which require propeller removal for oil change shall not be acceptable. Separate fill and drain plugs shall be provided to facilitate oil replacement.
2. Gear Driven Mixers: Each mixer shall be provided with an oil chamber for the shaft sealing system, and a second separate oil chamber for the gearbox. The drain and inspection plugs, with positive anti-leak seal, shall be easily accessible from the outside.

R. Gear Unit (Gear Driven Mixers Only)

1. The gearbox shall be a two-stage, cylindrical, helical gearbox equipped with high precision, low loaded gears designed for infinite life. The motor shaft shall be provided with an integral driving gear. The gearbox intermediate shaft containing the first driven gear shall mate with the motor shaft driving gear. The intermediate shaft shall rotate in two spherical roller bearings and contain the second driving gear. The propeller shaft shall contain the second driven gear and rotate in one single row and one double row, angular contact set of ball bearings.
2. All bearings shall be designed for a minimum of 100,000 hours operation.

S. Propeller

1. Direct Driven Mixers: The propeller shall be of 316 stainless steel, dynamically balanced, non-clogging backward curved design. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced.
2. Gear Driven Mixers: The propeller shall consist of two or three fiberglass-reinforced polyurethane blades, each integrated with a stainless steel shaft for mounting in a cast iron hub capable of handle changing hydraulic load conditions across their surface, thus shall capable of "flexing" and absorbing loads which would otherwise be transmitted to the gearbox and motor. Thus, metal blades will not be acceptable due to their inelasticity. Each blade shall be mounted into a socket in the side of the hub and will be held in place by a keyed propeller shaft to resist torsional forces, as well as a bolt and lock washer system along the axis of the propeller shaft. The blade shape shall be a nonclogging, backward curved design which starts at the hub leaving no part of the shaft exposed.
3. The propeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage applications.

T. Mounting Mast Assembly (Direct Drive Mixers)

1. Mast shall be constructed of 316 stainless steel
2. Mast shall enable the operator to position and lock the mounting mast and mixer at different operating angles along the horizontal and vertical planes respectively.

3. Mixer mounting system shall be designed to accommodate tanks with sloped walls and floors
4. For deep tanks, mixer mounting masts will include the use of additional intermediate mast mounting brackets, preventing mast deflection.
5. For closed tanks, utilizing the adjustable 316 stainless steel cable, the mixer shall be supported at the desired operating level, allowing the davit's lifting cable to be slackened and removed from the winch. This feature shall enable the portable davit to be removed from its mounting socket and stored, while the davit's lifting cable may be secured below the roof of the tank. This in turn permits the tank roof doors to be closed during mixer operation.

U. Tripod Guide Bar System (Gear Driven Mixers)

1. Mixer Mounting System shall be constructed of 304 stainless steel.
2. The Tripod Mounting system shall fix the elevation of the mixer at the optimum level at the time the system is installed.
3. The Tripod Mounting System shall be shipped in the nearest available coarse length (20, 25, or 30 feet), and must be fine-tuned by the installing Contractor in the field by cutting the nonwelded mast end to exact length shown on the Manufacturer's submittal drawings.

V. A davit crane socket and lifting cable shall be provided at each mast assembly or tripod station to raise and lower the mixers for installation and service. One portable davit crane shall be provided with lifting davit, winch, and hook, and 40ft lifting cable.

3.4 CONTROL PANEL

A. Scope of Work

1. The Manufacturer shall furnish a control panel that shall include a 15.5" touchscreen Graphic Operator Interface (HMI), Programmable Logic Controller (PLC) with I/O as specified on plans, Ethernet switch, Ethernet communications to SCADA, Uninterruptible Power Supply (UPS) for entire panel, DC power supplies, 120VAC discrete I/O provisions, NEMA 12 enclosure, Control Switches, and Pilot lights. PLC type, UPS type, redundant power supplies, etc. shall meet requirements specified in Specification Section 27 60 00 ("SCADA System") and

B. Specification Section 26 29 00 ("Manufactured Control Panels") unless noted otherwise.

Biological Process Control Logic

1. The operator shall be able to enable or disable any of the process control logic functions at any time through the HMI. When a control logic function is disabled, the equipment may be operated manually through operator inputted setpoints. The system shall enable the WWTP operator to be able to operate in a BNR mode, or in an aeration mode
2. Blower Control: The control system will interface with the blowers to provide the proper amount of air required for the system.

3.5 INSTRUMENTATION AND PROCESS CONTROL

Scope of Work

A.

1. The Manufacturer shall furnish, configure and commission the instrumentation for the biological process as indicated on electrical plans and schedules. In addition, the Manufacturer shall furnish the control algorithms as required to control the process. These control algorithms shall use data from all instruments furnished by the BNR (Aeration System) supplier, AND shall use data from other plant instruments (connected to SCADA PLCs with data provided to BNR/Aeration System PLC through the plant network) as directed by the civil engineer (from ammonia sensors, nitrate sensors, TSS sensors, phosphorous sensors, turbidity sensors, etc.). Refer to the "Instrument Schedule" on electrical plans for a summary of the instruments required to be furnished by the BNR supplier (the "Aeration System Supplier"). ALL new instruments (whether furnished by the SCADA Integrator or by the BNR/Aeration System Supplier shall fully comply with the detailed requirements of Specification Section 27 60 05 ("SCADA Instrumentation"). The BNR/Aeration System Supplier shall furthermore provide the sun/rain shields and surge protection devices for all instruments furnished by the BNR/Aeration System Supplier, in strict compliance with the requirements of the Instrument Schedule on electrical plans, Specification Section 27 60 05 ("SCADA Instrumentation"), and Detail "E-SRS" on the electrical plans. All sun/rain shields and field instrument surge protection devices on the project shall be of matching types. Coordinate with SCADA Integrator as required to ensure project consistency.

B. Air Flow Meter

1. Scope of Supply: The Manufacturer shall furnish insertion mass air flow meters for monitoring and feedback of airflow to the aeration basins. Flow meters are assumed to have the following characteristics:

Air Flow Meter Characteristics	
Flow Meter Diameter	6-inch
Flow Meter Range	0 – 3,000 scfm for individual zones 0-6,000 scfm for combined flow on air header
Power Supply	24 VDC

Manufacturer shall confirm and adjust flow range and/or other characteristics as required and as included in their proposal for the BNR system.

2. Installation: The air flow meter shall be mounted such that there is a section of straight pipe a minimum of 5 pipe diameters before the flow element and a minimum of 5 pipe diameters after the flow element. Each airflow meter shall be supplied with a flow conditioner to ensure accurate measurements with less than the recommended 10 pipe diameters before the flow element and a minimum of 20 pipe diameters after the flow element. The air flow meter shall be mounted downstream of the air control valve.
3. Construction – Flow Element

a. Connection Type: Male NPT Stainless Steel
b. Type: Insertion Thermal Dispersion
c. Body Material: 316 Stainless Steel with Adjustable Teflon Ferrule
d. Sensor Material: Hastelloy C
e. Temperature Range: 4 to 37 Degree C
f. Accuracy: +/- 1.0% of upper range value
g. Pressure Range: 0 to 15 PSIG

4. Construction – Transmitter

a. Casing: NEMA 4X Cast Aluminum, Epoxy Coated
b. Mounting: Remote
c. Output: 4-20 mA
d. Display Type: LCD (rate) in engineering units (scfm)

5. Surge Protection: Manufacturer shall provide external surge protection device(s) for all field wiring connections at transmitter in accordance with Specification Section 27 60 05 requirements.
6. Acceptable Manufacturers: FCI ST50 Series with VORTAB flow conditioner, or Equal.

C. Air Pressure Transmitters

1. Scope of Supply: The Manufacturer shall furnish insertion air pressure transmitters for monitoring and feedback of air pressure in the air header of the existing blowers with the following characteristics:

Air Pressure Transmitter Characteristics		
Connection Size	½	inch
Range	0-30	psig
Power Supply	24 VDC	V

2. Type: Force balance or electro-mechanical, two-wire, indicating with a remote diaphragm.
3. Function: Measure a pressure (either absolute, gauge, differential or vacuum) and produce an analog output signal directly proportional to that pressure.
4. Performance Specifications:

a. Range: As shown in table
b. Accuracy: +0.5 percent of the calibrated range
c. Deadband: +0.075 percent of span maximum
d. Rangeability: 100:1
e. Temperature Range: 0-300 degrees F
f. Output: 4-20mA DC

5. Required Features:

    a. Positive over-range protection of at least 1.25 times the maximum span limit
    b. Electronic zero and span adjustments
    c. Temperature compensation
    d. Static pressure compensation
    e. Adjustable internal dampening
    f. Field wiring Reversal: Accidental reversal of field wiring shall not damage transmitter
    g. Built-in electrical surge and RFI protection. Also provide an integral transient protection terminal block which meets IEEE standard 587 category B and IEEE standard 472.
    h. Weatherproof and splash proof NEMA 4X enclosure.
    i. ¾-inch NPT electrical conduit connection
    j. Designed to operate on power from receiver or other remote power supply at 24VDC
    k. Integral output digital LCD signal indicator
    l. ½-inch NPT process connection

6. Materials: Use transmitters constructed of the following materials. Materials shall be suitable for mounting on the blower discharge pipe which will have a temperature of up to 350 degrees F.

    a. Measuring element: Type 316 or 430 Stainless Steel
    b. Flanges: Type 316 or 430 Stainless Steel
    c. Bolts and mounting brackets: type 316 Stainless Steel
    d. Gaskets: Teflon
    e. Base and Cover: Die cast low copper aluminum with epoxy-based finish

7. Surge Protection: Manufacturer shall provide external surge protection device(s) for all field wiring connections at transmitter in accordance with Specification Section 27 60 05 requirements.

D. 8. Acceptable Manufacturers

    a. Hach or Equal.

DO/ORP Terminal/Controller

1. The analyzer shall be a digital multi-channel, multi-parameter system capable of controlling up to 20 sensors, in any combination, for the determination of water and wastewater parameters.

a. The controller must be configurable to include the following measurements: COD, TOC, DOC, SAC, BOD, pH, ORP, NH_4-N, NO_3-N, PO_4-P, Conductivity, DO, Turbidity, TSS, Temperature, and Sludge Level Monitor.
b. The controller shall receive 4 to 20 mA signals from third-party instruments.
c. Communication between controller and sensor shall be 4-20mA per parameter measured (multiple parameters are measured at some locations)
d. The system will provide up to 20 programmable analog outputs (max. load 500 ohms) and 20 programmable alarm relays (rated to 5A at 250VAC). System shall also be capable of Ethernet/IP and Profibus IP communication.
e. 90VAC-264VAC power required.
f. Enclosure is NEMA-4X rated.
g. Entire system including the sensors shall have built in lightning and surge protection.
h. Ambient operating temperature –20°C to +55°C.
i. System diagnostics shall be standard.
j. System shall also have a USB interface port, data storage capability, and 3 levels of security.
k. System must have integrated lightening and overvoltage protection.
l. Backup controller function to increase reliability.

2. The terminal controller shall be YSI/WTW model 2020 IQ Sensor Net or Hach equivalent.
3. All instruments associated with the biological system must be connected to a terminal/controller for 4-20mA signaling back to the Control Panel.
4. Universal Mounting Kits with all necessary hardware shall be provided for each sensor.
5. A sunshield and mounting bracket shall be provided for the system display/controller and each local component to be mounted outside per the detail shown on electrical plans.
6. Surge Protection: Manufacturer shall provide external surge protection device(s) for all field wiring connections at transmitter in accordance with electrical specifications in the Contract Documents.

E.

DO/ORP Instrumentation

1. Each aerated zone shall be equipped with dissolved oxygen and/or oxidation-reduction potential probes as shown on the drawings and recommended by the Manufacturer.
2. Dissolved oxygen probes shall be a Hach LDO sc Model 2 or approved YSI equivalent.

a. Communication to controller shall be analog 4-20mA.
b. Connection to terminal controller shall be through two-wire shielded cable.
c. The sensor shall be calibration-free using intelligent membrane technology.
d. Membranes shall last up to two years with replacement membranes containing calibration data chip.

e. Sensor shall use soft green fluorescent light with calibrated optics and equal path reference system.
f. Sensor shall have a measuring range of 0-20.00 mg/l.
g. Sensor shall integrate temperature measurement and compensation.
h. Temperature operating range of -5° C to + 50° C and measuring range of -5° C to + 50° C.
i. System accuracy shall be ± 0.05 mg/l < 1.00 mg/l, ± 0.1 mg/l > 1.00 mg/l.
j. Sensor shall include self-diagnostics.

3. The ORP sensor shall be a Hach pHD sc ORP or approved YSI equivalent.

a. Communication to controller shall be digital with calibration value storage.
b. Connection to terminal controller shall be through two wire shielded cable.
c. The sensor assembly shall include pre-amplification of electrode signal.
d. Sensor assembly shall include an integrated NTC thermistor.
e. Sensor shall have a measuring range of +/- 2,000 mV.
f. Temperature operating range of -5° C to + 70° C.
g. Sensor shall include self-diagnostics.

4. The dissolved oxygen and oxidation reduction potential signals shall be displayed at the main control panel display unit and be an input to the PLC. The PLC, using a control algorithm will output a 4-20ma signal to control the air flow to each aeration basin. The control system will control the airflow to provide only the amount of air required to maintain the dissolved oxygen setpoints.
5. Probes and terminal controllers shall be handrail mounted as shown in the drawings, using stainless steel mounting brackets and 1-1/2” PVC mounting poles.

F. Aeration Control System

1. The control system will interface with the blowers to provide the proper amount of air required for the system. The blowers have the following design:

Parameter	New Blowers	Units
Quantity	3	-
Air Flow*	2,799	scfm
Discharge Pressure	11.39	psig
Motor Shaft Power (Each)	200	hp
Design Break Horsepower (Each)	163.6	Bhp

2. The control system will control the airflow to each aerated zone with an airflow modulating valve and air flow meter.

3. The control system will promote low system pressure by adjusting the air main pressure setpoint while ensuring adequate air supply to the process.
4. The DO and ORP signals shall be displayed at the main control panel display unit and be an input to the PLC. The PLC, using a control algorithm will output a 4-20ma signal to control the air flow to each aeration basin. The control system will control the airflow to provide only the amount of air required to maintain the dissolved oxygen setpoints.

Pulsed Aeration

1. A control algorithm shall be provided to intermittently cycle the air supply rate to the aeration grids in the system as described herein.

G.

   a. Under normal operation, the airflow rate to each grid will be controlled by a DO and/or ORP probe.
   b. At any time during automatic aeration control, the air supply rate to a grid drops below the minimum airflow needed to maintain mixing liquor solids in suspension, a mixing timer shall start.
   c. If the air supply rate to that grid rises above the minimum airflow needed to maintain mixing liquor solids in suspension, the mixing timer will be re-set to zero.
   d. If the value of the mixing timer exceeds a user-defined setpoint, the controller shall pulse the aeration rate to that grid to the minimum airflow needed to maintain mixing liquor solids in suspension for a period of time sufficient to re-suspend any settled solids, and then re-set the mixing timer to zero.
   e. The controller shall determine the maximum allowable number of aeration grids allowed to pulse simultaneously using the user-defined time between pulses and the pulse time required to re-suspend any settled solids.
   f. The controller shall be designed to ensure uniform air distribution to all diffusers in each grid at the minimum airflow rate allowed for each aeration grid.
   g. The controller shall adjust the airflow rates to each grid gradually to avoid sudden variations in pressure to the blowers.

2. The system airflow rate shall be controlled using most open valve (MOV) or pressure header control as described in this specification.
3. The user-defined setpoint for time between mixing pulses and the status of each grid (Aeration Control or Pulse) shall be displayed on the HMI.

A.

B. 3.6 SHOP OXYGEN TRANSFER TEST

Conduct a performance test to demonstrate capability of the aeration equipment to meet the specified oxygen transfer requirements.

Base all tests on the following criteria:

1. A minimum of 3 tests for each specified condition in complete accordance with ASCE Clean Water Test Procedure (1992 or latest edition).

2. Manufacturer to conduct tests in a full-scale aeration test tank (minimum of 300 sq. ft.) at the specified submergence and water depth with a diffuser density equivalent to the specified tank configuration. Diffuser density is defined as the ratio of the total tank surface area to the total active diffuser surface area.
3. Conduct shop test with air rate and mass rate of oxygen transfer directly proportional to the ratio of the shop test tank volume and the design tank volume.
4. Plot of pounds of oxygen per day per 1,000 cubic feet of tank volume versus air per 1,000 cubic feet of tank volume in tap water at 14.7 Asia, 20°C and zero dissolved oxygen at the specified submergence.

Certify and stamp all tests by a registered Professional Engineer.

C. Include all costs for testing (exclusive of witnesses expenses) in the equipment price. All tests may be witnessed at Owner/Engineer option. Cost of travel and living expenses for Owner/Engineer to be paid by the Owner.

D. Submit all test data from oxygen transfer tests for approval by the Engineer prior to manufacturing equipment.

E.

PART 4 - EXECUTION

4.1 INSTALLATION

A. Contractor shall furnish, inspect, store, and install aeration system and blower components in accordance with Manufacturer's written instructions and approved submittals.

B. Diffuser assemblies on a common grid shall be installed within an elevation tolerance of ±1/2 inches.

C. Contractor shall provide all valves, air header piping, wall sleeves with seals, wall pipes, and concrete pedestals as necessary to complete the system as shown on the plans.

D. Air piping including blower manifold, header, and in-basin piping must be clean prior to delivering air up the diffusers.

E. Contractor shall be responsible for cleanliness of piping and may be required to manually clean pipe, or air or water flush piping as required.

4.2 QUALITY ASSURANCE

A. The Manufacturer shall have experience in the design, manufacture, supply, and commissioning of fine pore, flexible membrane aeration equipment of the type specified for this project.

B. Manufacturer shall have available skilled supervision and startup services as specified.

C. The Contractor shall provide the services of the Manufacturer service/startup technician to supervise and inspect and certify the equipment is operating as designed. The Manufacturer will provide classroom and field training on the operation and

maintenance required at each installation. The Manufacturer shall provide a factory trained service/startup technician for two (2) trips including a total of eight (8) workdays to inspect the installation, observe/assist in startup and supervise the performance testing and Owner's training. The Manufacturer's service/startup technician days on site shall be 8 hours per day not including travel time. The Manufacturers service/startup technician shall provide additional time on site at no cost to the Owner if required to resolve startup issues associated with the system equipment, programming or other issues due to system design or performance. Any additional days on site, if requested by the Owner, shall be negotiated between the Owner and the Manufacturer.

D. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the service engineer present.

E. The service engineer shall make all necessary adjustments and settings to the controls.

F. The service engineer shall demonstrate proper and sequential operation of the system. The system shall be able to operate fully automatically.

G. The Owner will NOT provide written acceptance of the system until training is complete.

4.3 OWNER ACCEPTANCE

A. In addition to the documentation associated with the completion of the Acceptance Testing, the Manufacturer shall provide the Owner with documentation that states the installation of the system has been inspected, meets the Manufacturer's guaranteed requirements, and is free from faults and defects. Once this documentation is received and training is complete, the Owner will issue a written letter of acceptance.

4.4 PERFORMANCE GUARANTEE AND WARRANTY

A. The Manufacturer shall provide a performance guarantee that states the following:

1. The Manufacturer hereby unconditionally and irrevocably guarantees to the Owner, the performance and operating parameters described in these specifications and as submitted in the Manufacturer's proposal.
2. The BNR system Manufacturer agrees the system performance shall be based on field measurements from instrumentation as monitored by the Owner. The Owner agrees to notify the BNR system Manufacturer if the guaranteed performance and operating parameters are not met.
3. In the event that the system fails to perform at the guaranteed levels of performance and operation, as defined in the Xylem process performance guarantee included in the notice of award in the Appendix of this section, the Manufacturer agrees to pay the Owner 100-percent of the operating costs differential for the period of time beginning after written notification of non-compliance is received by the Manufacturer and continuing until the system is again operating within these specifications.
4. The Manufacturer agrees to pay to the Owner all reasonable costs and expenses, engineering, legal or otherwise, which may be incurred in the successful enforcement of any liability of the Manufacturer under this performance guarantee, subject to the limitations defined in the Xylem process performance guarantee

included in the notice of award in the Appendix of this section.

5. The Manufacturer shall furnish a three (3) year performance bond covering satisfactory performance of the BNR system equipment; FOB to Shenandoah WWTP and shall include parts only (not labor). The performance bond shall be in an amount to cover complete replacement of all system equipment, all of which will comply with the performance requirements required and guaranteed by the Manufacturer. Obliges of the Bond shall be the Owner and the Contractor. Bonds shall be furnished with the Manufacturer as principal and with corporate surety satisfactory to the Owner and authorized to do business in the State of Georgia and countersigned by an agent whose office is located in the State of Georgia.

B. Manufacturers shall provide a 1 year warranty for all system components from the date of successful startup and Owner acceptance.

4.5 SPARE PARTS

A. A recommended spare parts list shall be furnished by the Manufacturer.

END OF SECTION 44 46 13

SECTION 44 42 15 - ROTARY LOBE BLOWERS

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install complete, ready for operation and field-test three (3) new rotary lobe compressors to be installed in the Aeration Basin Blower Building and two (2) new rotary lobe compressors to be installed Digester Blower Building and appurtenances, as shown on the Drawings and as specified herein.

B. The entire compressors and components shall comply with all applicable safety and environmental regulations.

1.2 SUBMITTALS

A. Submit per the Contract Documents, copies of all materials required to establish compliance with this Section. Submittals shall include at least the following information:

1. Certified general arrangement drawings showing materials, details of construction, dimensions and connections.
2. Performance Data at the Design Point and all operating points are listed below:

    a. Actual Operating Speed (RPM) and % of maximum rated speed
    b. Capacity – scfm and icfm
    c. Design inlet conditions, pressure, temperature and relative humidity (%)
    d. Discharge pressure
    e. dB(A) noise pressure level
    f. Blower Shaft HP, Motor HP and Package HP

3. List of recommended spare parts broken down into on hand parts and long term for 2 years operation and 3 to 5 years operation.
4. Descriptive Brochures
5. Motor Data
6. Instrumentation and Wiring Diagram
7. ISO-1217 Factory Performance Test Results. Slip test results shall not be unacceptable as an alternate. Manufacturer shall provide documented results for the purchased machines. Typical or average data shall not be acceptable.
8. ISO-8573-1 Class Zero Oil Free Certificate
9. Declaration of Conformity, per Machinery Directive 2006/42/EC, Annex II, No.1 A.

B. Complete blower package operating and maintenance instructions professionally published, hard copy and electronic copy, shall be furnished for all equipment included under these specifications in accordance with the Contract Documents.

1.3 QUALITY ASSURANCE

A. Qualifications

1. Aeration Basin Blowers – Manufacturers

a. Aerzen – Delta Hybrid Model D98S – (Qty 3)
b. Approved equal

2. Digester Blowers – Manufacturers

a. Aerzen – Delta Model GM 080L-00 – (Qty. 2). These blowers shall match the existing blower previously purchased by the Owner and installed under a separate contract. The full submittal for the existing blower shall be made available to bidders during the bid phase of this project. The new blowers shall be provided with factory installed sound enclosures and a sound enclosure shall be provided for the existing blower to be installed by a factory trained technician. The new blowers shall be furnished with overtemp and overpressure dry contacts (n.o. vs n.c.) to match the existing blowers/controls (which are intended to be reconnected to the new/replacement blowers.

3. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings.
4. The rotary lobe compressors shall be covered by a warranty for 24 months from date of commissioning, or 30 months from date of shipment, whichever occurs first.

1.4 BLOWER PERFORMANCE CRITERIA

A. Aeration Basin Blowers

1.	Quantity of Machines	3
2.	Design Inlet Temperature	100 ˚F
3.	Site elevation	820 ft
4.	Design Inlet Pressure	14.35 psia
5.	Design Relative Humidity (%)	85 %
6.	Design Flow	2,799/3,123 scfm/icfm per blower
7.	Design Discharge Pressure	11.39 psig
8.	Design Blower Speed	3,570 RPM
9.	Brake Horsepower (Max)	163.6 bHp
10.	Motor Size (Max)	200 Hp
11.	Sound Level w/Enclosure	77 dB(A) at 1 meter (at design point)

B. Digester Blowers

1.	Quantity of Machines	2
2.	Design Inlet Temperature	100 ˚F
3.	Site elevation	818 ft
4.	Design Inlet Pressure	14.27 psia
5.	Design Relative Humidity (%)	85 %
6.	Design Flow	2,252/2,595 scfm/icfm per blower
7.	Design Discharge Pressure	6.57 psig
8.	Design Blower Speed	3,570 RPM
9.	Brake Horsepower (Max)	98.4 bHp
10.	Motor Size (Max)	100 Hp
11.	Sound Level w/Enclosure	77 dB(A) at 1 meter (at design point)

a. BHP to include pressure loss through a clean inlet filter / silencer, pressure loss of the exhaust silencer and check valve.
b. Performance shall be guaranteed to ISO 1217 with a tolerance is +/- 5% on volume flow and +/- 5% on package horsepower. Manufacturer of blower shall provide data for purchased machine.
c. Sound data shall be from an ISO 2151 method of measurement, in an ISO 3745 qualified test facility. Sound data shall be compliant with a Declaration of Conformity assessment standard.

1.5 DELIVERY, STORAGE AND HANDLING

A. All equipment shall be completely factory assembled, skid mounted, crated and delivered to protect against damage during shipment.

B. All exposed flanges shall be covered and sealed with shrink-wrap to prevent the entrance of moisture or debris. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

C. All equipment delivered to the site shall be stored as specified in accordance with the manufacturer's instructions.

1.6 MAINTENANCE

A. Spare Parts

1. Furnish the following spare parts for each blower package specified:
   a. Complete set of matched V-belts
   b. Two inlet air filter elements
   c. One oil filter element
   d. One volume of oil for first service interval

2. Spare parts shall be properly bound and labeled for easy identification without opening the packaging

PART 2 – PRODUCTS

2.1 GENERAL

A. Rotary Lobe Compressors shall be designed to minimize the life-cycle costs and maximize plant reliability. The design and the selection of the components shall be based on a minimum useful life of 20 years and a Mean Time Between Overhauls of 5 years of continuous operation. Bearing life shall be submitted by manufacturer of the blower stage, based on specified conditions.

B. Manufacturer shall guarantee that the rotary lobe compressor shall provide oil-free operation and be certified to ISO 8573-1 Class Zero.

C. Blower Casing:

1. The casing shall be of one-piece construction, with separate sideplates that are bolted and pinned to the housing.

2. Casing materials shall be close-grained cast iron ASTM A48 suitably ribbed to prevent distortion under the specified operating conditions.
3. Inlet and outlet shall be flanged connections, not threaded.
4. Airflow shall be vertical top to bottom with inlet and outlet connections offset so that the flow travel horizontally across the blower stage. Casings that do not utilize a horizontal internal flow shall not be allowed.
5. The vibration level as measured at the casing, in the X/Y planes of the bearings, shall not exceed 0.3 "/ sec RMS when operating at the specified operating pressure and speed. The vibration level shall be checked at start-up and documented in the field start up report.

D. Factory Testing:

1. Each rotary lobe compressor stage shall be factory performance tested in accordance with ISO 1217 standards to verify flow and brake horsepower. A slip test shall not be acceptable, nor is average data for the manufactured size.
2. The acceptance criteria are +5% tolerance on power and –5% tolerance on flow regardless of the size of the machine.
3. The manufacturer shall submit free field noise data for the complete blower package. The results have been obtained using an ISO 2151 method of measurement, in an ISO 3745 qualified test facility. The performance data shall include a Declaration of Conformity, per Machinery Directive 2006/42/EC, Annex II, No.1 A.

E. Rotors:

1. Each rotor (male and female) shall be of the "stiff" design with first lateral critical speed at least 120% of the maximum allowable operating speed.
2. The rotors shall operate without rubbing nor shall they require lubrication.
3. Rotors shall be drop forged in one single piece of AISI 1043 or equivalent.
4. Open rotors shall not be acceptable.
5. For maximum strength and reliability, the female rotor shall be driven by the drive motor and the male rotor shall be driven by the timing gear set. Stages that utilize a male driven rotor shall not be accepted.
6. A male and female rotor configuration with internal compression ratio and axial flow entry must be used to increase the adiabatic efficiency of the blower stage. Twisted rotor profiles applied for pulsation cancelation only shall not be allowed. Radial flow entry type rotors shall not be allowed.
7. Only precision-machined rotors with sealing strips to optimize clearance and performance shall be accepted. Manufacturers using coated rotors are required to include the following additional services in their proposal, with a broken out adder to their proposed cost:

    a. For the first 5 years of service, the manufacturer will visit the site. Each machine will be shut down and visually inspected for evidence of degradation. Inspection will include clearance measurement with feeler gauges. An annual report will be submitted, including photographs, for each machine.
    b. An annual performance test will be performed on site, including flow and power measurement, for each machine. The results will be compared to the original ISO-1217 test results for each machine, and a report submitted to the owner and the engineer.

c. Any sign of performance loss or coating degradation will be monitored. If the engineer or owner determine that the results pose a threat to the reliability of the aeration system over the first five years, the manufacturer will, at their own expense (including parts and labor) replace the designated compressor stage, or overhaul and recoat the existing stage, depending on the number of units affected by the degradation.

8. Rotors shall be statically and dynamically balanced per ISO1940/ANSI S2.19 G2.5.

F. Bearings:

1. Each rotor/shaft shall be supported by anti-friction bearings, and fixed to control the axial location of the rotor/shaft in the unit.
2. Regardless of theoretical bearing life calculations, the bearings shall be sized for a minimum expected life of 5 years between overhauls.
3. The applied design conditions shall yield a bearing load and minimal L-10 bearing life calculation of 700,000 hrs. Calculated bearing life shall be submitted, based on specified operating conditions.

G. Timing Gears:

1. The rotors shall be timed by a pair of single helical gears with quality equivalent to AGMA 12.
2. Gears shall have hardened and ground teeth and a minimum AGMA service factor of 1.70.
1. Gears shall be mounted via hydraulic expansion onto the shafts with a tapered interference fit and secured by a locknut.

H. Seals:

1. Seals shall be designed to prevent lubricant from leaking into the air stream as well as to prevent oil from leaking out of the machine.
2. The seal shall consist of two rotary slip rings mounted in a retainer with an atmospheric air gap in the center.
3. The rotor shaft shall be protected by a shaft sleeve.
4. An O-ring shall be provided under the shaft sleeve to prevent oil migration along the shaft into the air conveying chamber.

I. Lubrication:

1. The timing gears and the bearings shall be oil lubricated. Grease lubrication shall be not acceptable.

J. Oil Sight Glass:

1. An oil sight glass shall be provided on the exterior of the noise enclosure so the operator can easily view the oil level.
2. Sight glasses inside the enclosure or that cannot be easily viewed by the operator shall not be acceptable.

K. Painting:

1. Painting shall be per supplier's standard meeting the following criteria:

    a. Except for machined sealing and machined mounting surfaces, the package shall be painted dark blue.
    b. Aluminum, stainless steel, and brass shall not be painted.
    c. The supplied motor shall not be over sprayed and will be supplied with the motor manufacturer's standard protection and paint color.
    d. Painted Cast Iron and Carbon Steel shall be Alkyd Resin Primer and Final coat with a total dry film thickness of 70□m. Surface preparation SSPC10 or better.
    e. Sound enclosure shall be powder-coated polyester base total dry film thickness 80□m.
    f. Galvanized components shall only be painted with appropriate surface preparation

2.2 BLOWER ACCESSORIES

A. Inlet Filter / Silencer:

1. Each package shall be supplied with one combination inlet filter and silencer.
2. The inlet filter silencer shall be mounted directly to the inlet flange of the blower.
3. The filter media efficiency shall meet the requirements of ASHRAE 52.2 MERV7 50-70% @3-10 microns corresponding to EN779 G4.
4. The silencer portion shall be located upstream of the inlet filter.
5. The filter element shall be designed to trap dirt on the inside so that upon changing, dirt does not fall into the machinery.
1. Filter and silencer performance losses (clean element) shall be included in the entire package performance calculation.

B. Base Frame / Discharge Silencer:

1. Each package shall be supplied with one combination base frame / discharge silencer
2. The silencer shall be a chamber type design for maximum sound attenuation and shall not use internally any absorption materials of any kind (fibrous or otherwise).
3. The silencer shall be fabricated of a single shell of pressure vessel quality steel with continuous welds.
4. The silencer must be subject to a pressure test for tightness and strength at a minimum of 1.65 times the maximum design pressure.
5. The silencer shall have a machined flanged inlet connection and bolt directly to the discharge flange of the rotary lobe compressor, with no intermediary or interconnecting pieces.
6. Discharge silencer performance losses shall be included in the entire package pressure calculation.
7. The base frame shall be constructed from welded carbon steel that shall be designed to maintain alignment of the blower internal components and the drive during operation.
8. The base frame shall be designed to resist distortion while being installed on vibration isolating mounts.
9. The manufacturer shall supply a stainless steel grounding lug fully welded to the base.

C. Flexible Connectors:

1. Each package shall be provided with a flexible ANSI style discharge connector and upstream of the inlet silencer.
2. Flexible connectors shall prevent the transmission of noise and vibrations from the blower package into the piping.
3. Flexible discharge connectors shall be Proco Style 240, Type EE, EPDM, with a standard ANSI flange discharge connection, rated for 300 °F at 20 psig. Soft face range with galvanized split ring reinforcement.

D. Electric Motor:

1. Each package shall be supplied with a WEG manufactured TEFC NEMA Premium Efficiency motor that shall operate on 460 Volts, 3 Phase, 60 Hertz current, 3600 RPM.
2. Motors shall be horizontal, foot mounted, rigid base, Torque NEMA B, Temperature rise Class B, TEFC IP55, watertight and dust tight enclosure.
3. Class F, inverter rated insulation, Class H applied varnish, 3:1 constant torque VFD-duty.
4. Regreasable bearings, positive pressure lubrication system with automatic drawn plugs – pressure compensated (frame sizes 254T and larger).
5. All frame sizes shall be NEMA standard, suitable for overhung belt drive and with the conduit box on top of the motor. IEC frame motors shall not be allowed.
6. The motor will be mounted on a pivoting base to provide automatic tensioning of the belts. The motor nominal rating after any corrections for ambient conditions shall be 10% above the maximum operating horsepower.
7. The motor shall have a 1.25 service factor for sizes up to 100 HP and a 1.15 service factor for sizes above 100 HP.
8. Motor windings shall be supplied with a 120VAC thermostat, one per phase, wired in series (for n.c. thermostats) or in parallel (for n.o. thermostats) to form a motor protection circuit for the external fault circuit of the motor controller on all frame sizes. Thermostat shall be a Klixon Precision Thermostat by Sensata Technologies. Aeration blower thermostats shall be normally-closed, and digester blower thermostats shall be normally-open (to close on overtemp) to match existing control system.
9. Blower manufacturer shall be responsible for coordinating the starting torque requirement of the blower and the motor.
10. The use of the TEFC motor to cool the blower system or circulate the enclosure air shall not be allowed.

E. Start Unloading Valve:

1. An unloading valve is not intended to provided with the blower and the electrical controls are not designed for this type of valve. Should an unloading valve be required, the rotary lobe compressor manufacturer shall supply it, and shall be responsible for coordinating all requirements (prior to bid) with the contractor for the contractor to include associated electrical costs (for solenoid valve control/interconnections, etc.).
2. Unloading valve shall be an automatic type pneumatically operated valve requiring no electrical nor compressed air connections mounted upstream of the check valve.

3. A solenoid shall be supplied for electronic regulation of the unloading valve, removing the fully automatic function of the valve specified above.

F. V-Belt Drive:

1. Each package shall be supplied with a V-belt drive that shall be of the high capacity type, oil and heat resistant.
2. Drive shall be designed for a minimum service factor of 1.4 times operating power (bHp), or 1.1 times the motor nameplate Hp, whichever is larger to allow a minimum of 1.4-service factor based on the maximum blower bHp.
3. Belt tensioning shall be automatic without the use of any spring devices or interaction on the part of the operator. Slide rails or spring tensioners shall not be used as a tensioning device.
4. Sheaves shall be dynamically balanced regardless of the operating speed and hydraulically mounted on the compressor drive shaft.
5. The automatic tensioning system shall yield a v-belt life of 16,000 hrs of operation.

G. Belt Guard:

1. The belt drive shall be guarded in compliance with OSHA regulations.
2. Portions of the guard shall be easily removable allowing for belt inspection and replacement.
3. Guard material shall be perforated galvanized carbon steel.

H. Vibration Isolators:

1. Each package shall be supplied with vibration isolating feet with a minimum efficiency of 80%.
2. The manufacturer shall be responsible for attenuating noise and vibration in the package such that no special installation base shall be required, nor shall any additional measures be required to reduce vibrations from the package being transmitted to the base or the piping.

I. Pressure Safety Valve:

1. Each package 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.
2. The safety valve shall be set to protect the machine from exceeding its maximum pressure rating, and shall be sized to pass 100% of the design flow.
3. The valve shall be field adjustable, spring loaded, and have a certificate of conformity to PED if operating above 15 psig.
4. The pressure safety valve shall be housed inside and attenuated by the sound enclosure. The safety valve shall relieve hot air into a segmented and sealed section of the sound enclosure so that the hot air cannot reenter the inlet of the machine. Weighted relief valves inside the enclosure shall not be permitted. Diaphragm electronically actuated relief valves shall not be permitted.
5. The valve shall be manufactured by the blower manufacturer.

J. Digester Blower High Pressure Switch:

1. Each digester blower shall be provided with a 120VAC-rated high pressure switch (normally-open, to close on high pressure alarm) to match the existing blower control system.

K. Check Valve:

1. Each package shall be supplied with one check valve that shall be installed on the discharge line.
2. The check valve shall be of the full-bore low pressure-drop, flapper type design with a steel body, and steel flap embedded in EPDM with full-contact seal.
3. The valve shall be easily removable without disturbing the piping. Check valves requiring installation in the discharge piping shall not be considered, unless installation cost of the external valve is included in supplier's proposal.
4. Pressure losses produced by the check valve shall be included in the entire package performance calculation.
5. The check valve shall be manufactured by the blower manufacturer.

L. Local Control Panel – Aeration Basin Blowers Only:

1. Each package shall be supplied with the following control functions and features:

a. Intuitive TFT color touch screen display.
b. Display, monitoring, alarm, and shutdown of inlet pressure, discharge pressure, discharge temperature, enclosure cooling fan thermal overload, main drive motor thermal overload, oil temperature and oil pressure.
c. Display run hours
d. Log errors and first out indication
e. Track and log maintenance
f. E-Stop button mounted on front of blower enclosure
g. Operation of enclosure cooling fan motor starter and oil demister
h. Ability to transfer measured values, fault and status messages, as well as remaining times of the service intervals to the customer control system via Ethernet IP.
i. Permissive control function of customer start and stop signals to a motor controller
j. Digital potentiometer (EM4 Module)
   i. LOCAL Operation: speed control of the VFD via the HMI screen.
   ii. REMOTE Operation: transfer of VFD speed command from external controller to the VFD
   iii. These signals can be communicated using either hard wire connection or the communication protocol
k. The local control panel shall be provided with the following digital outputs:
   i. Common alarm
   ii. Common fault
   iii. Ready to run
   iv. Transfer of external start/stop command
   v. Status remote
   vi. Maintenance required
   vii. Alternatively, these outputs can be obtained using the communication protocol
l. The local control panel shall be provided with the following digital inputs:
   i. Remote start/stop

ii. Motor controller fault
iii. Customer E-stop
iv. Load/unload
v. Alternatively, these inputs can be supplied using the communication protocol

2. Control Enclosure

   a. IP54 suitable for indoor/outdoor installation
   b. NEMA 12
   c. Factory installed, integral to sound enclosure

3. Control Supply Power

   a. 460 VAC, 10 Amp feed with 24 VDC transformer

4. Monitoring Sensors

   a. Inlet Pressure Transducer
   b. Discharge Pressure Transducer
   c. PT 1,000 Discharge Temperature RTD
   d. PT 1,000 Oil Temperature RTD
   e. Oil Pressure Transducer

5. Local control panel shall be the Aerzen AERtronic Digital Controller or equal.

6. Digester Blowers shall be connected to the existing control panel and protective devices.

M. Each blower shall receive its initial oil filling at the factory. Oil to be fully synthetic and rated for 16,000 hours of operation between change intervals.

N. Acoustical Sound Enclosure:

1. Aeration Basin Blowers - Qty – 3
2. Digester Blowers – Qty – 3
   a. Two installed at factory and delivered to site.
   b. One delivered loose to site to be installed on the existing blower by a factory-trained technician.
3. The enclosure shall provide suitable protection for outdoor installation under wind loads of 50mph and snow loads of 25lbs/ft^2.
4. The enclosure shall be designed so as to be able to install them side-by-side with all maintenance done from the front or back of the package.
5. Details shall be as follows:

   a. Enclosure Panels shall be made of galvanized steel sheet, powder coated in a light reflecting, blue color per RAL 5001. The skid shall be of the same color.
   b. Sound enclosure acoustic material shall comply with UL 94 - HF1 for fire-retardant, self-extinguishing, non-dripping materials.

c. The enclosure and the blower package shall both be mounted on a skid / oil-drip pan designed for meeting environment protection standards and for easy transportation and installation.
d. A grounding strap shall be installed between the blower base and the package skid to bypass any vibration isolating mounts for grounding continuity.
e. Quick release panels, each less than 50 lb (as mandated by MSHA) must provide easy and quick access for routine maintenance of the blower and the package components.
f. Enclosure Cooling / Ventilation Fan:

    i. Ventilation fan shall be provided for cooling the sound enclosure.
    ii. The fan shall be sized for sufficient heat removal from the sound enclosure, even when the blower is operated with a VFD.
    iii. The cooling fan shall be driven separately by a 460V, 3Ph, 60Hz electric motor powered by the same 460 VAC electric feed as the local control panel. A 120V single phase motor for this application will not be acceptable as the current draw and motor operating temperature are too high.
    iv. The enclosure cooling fan shall be a dedicated device. The use of the TEFC drive motor to cool the blower or circulate the sound enclosure shall not be allowed.

g. To prevent possible operator damage, electrical components, instrumentation and instrument connections shall not be mounted or interface with moving panels of the sound enclosure.
h. Both blower oil sumps shall be piped to a common fill and drain, located at the front of the package for easy maintenance. An oil level indicator shall be mounted on the outside of the enclosure, which gives an accurate oil level indication while the blower is in operation. All oil lines shall be industrial-quality hydraulic hose and fittings.
i. Enclosure space heater:

    a. Machines with pressurized lubrication systems will require enclosure space heaters or oil heaters when operating outdoors at temperatures below -10C (14F)

PART 3 – EXECUTION

3.1 INSTALLATION

A. The Contractor shall install the rotary lobe compressors in accordance with the manufacturer's written instructions.

B. The Contractor shall make all electrical and process connections to the blower package prior to the arrival of the manufacturer's representative.

C. Manufacturer's authorized service technician shall verify proper installation, electrical connections and equipment alignment prior to start up.

3.2 FIELD SERVICE & TESTING

A. After installation of all equipment has been completed and as soon as conditions permit, the manufacturer shall provide one (1) trip for a total of two - (2) 8 hour days to verify the installation and conduct an acceptance test under actual operating conditions.

   1. The Manufacturer shall perform a physical check of the blower installation, perform safety checks, power up the equipment and perform functional testing.
   2. The functional test shall consist of 4 hours of operation of each blower with vibration, temperature, and pressure readings as well as motor amp readings taken and recorded at 60-minute intervals.
   3. Installed noise measurements shall be taken to compare the installed noise values with the factory free field ISO 2151 measurements.
   4. The Manufacturer shall provide operations and maintenance training to the plant personnel. The training shall consist of 1 hour of classroom training using the Operation and Maintenance Manual for reference and 2 hours of hands on training at the blower package.

B. If required, Contractor shall make any changes, at his own expense, to the installation that may be necessary to assure satisfactory operation. Contractor shall be held liable for changes needed in the installation.

C. Manufacturer shall provide a written field test / start up report after completion of testing.

D. After successful startup and field testing, the manufacturer shall provide one (1) trip for a total of one- (1) 8 hour day for end user training.

E. Within seven (7) months of startup, the manufacturer shall provide one (1) trip for a total of one - (1) 8 hour days for post startup inspection of the equipment and additional training.

END OF SECTION 44 42 15

SECTION 44 42 26 - SELF-CLEANING SCREEN

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. Under this section of the specification, the contractor shall provide and install the as shown in the contract drawings and as described herein.

B. The equipment shall include, but not be limited to, a mechanical bar/filter screen unit, consisting of a frame assembly, filter belt/screen assembly, drive assembly, rotating brush assembly, screenings compactor and system control panel.

C. This equipment shall be provided as an integral package by a single manufacturer who shall take responsibility for coordination of all components to assure proper functioning of the sedimentation equipment as a system.

1.3 SUBMITTALS

A. **Certification from Contractor and Manufacturer/Suppliers:** During the bid period and again prior to submitting/ordering and installing materials, products and equipment, the Contractor and all manufacturers and suppliers shall thoroughly review the materials, products and equipment being supplied and shall familiarize themselves with the existing and proposed/new facilities, as well as connections to existing facilities/utilities. This shall include field verification of the location, nature, size/dimensions, current and intended future use, etc. Prior to ordering and installation, the Contractor shall coordinate with all manufacturers and suppliers to provide all needed information including field dimensions, photographs, information on related materials and equipment, etc.). The Contractor and all manufacturers and suppliers shall include written confirmation (with the submittal) of the following:

1. The materials, products, and equipment being supplied are of the correct size, materials and type.
2. The materials, products and equipment being supplied do not conflict with existing or proposed/new facilities.
3. The products/equipment being supplied are intended for use in this application.
4. All manufacturer(s) and supplier(s) shall provide (either with submittals or separately) written concurrence/acknowledgement of their review/coordination and concurrence with the items above.
5. Shop drawings and product data submitted for review by the Engineer shall bear the Contractor's certification that he has reviewed, checked, and approved the submittals, that they comply with the requirements of the project and with the provisions of the Contract Documents, and that he has verified all sizes, dimensions, locations, field measurements, construction criteria, materials, catalog numbers, and similar data. Field dimensions, sizes and other pertinent information shall be clearly shown on the shop drawings/submittals. The

Contractor shall also certify that the work represented by the shop drawings is recommended by the Contractor and that the Contractor's warranty and guaranty will fully apply.

B. The contractor shall provide product data, drawings and calculations as follows:

1. Basic design, layout, and detailed equipment drawings.
2. Design calculations including upstream and downstream water elevations at low average and peak flow rates.
3. A statement of the terms of the warranties.
4. List of spare parts which should be purchased and kept on hand.
5. All ancillary equipment to be provided by the manufacturer shall be listed.
6. Complete shop drawings of all equipment furnished including cut-sheets describing sub-components with the specific components highlighted.
7. Operation & Maintenance Manuals

C. The Contractor, equipment manufacturer(s) and/or supplier(s), and representative(s) shall be responsible for reviewing the specified equipment during the bid period, and confirming that the specified equipment and appurtenances are suitable for use in this application, and, for notifying the Engineer immediately upon discovery of any issues with the use of the equipment in this application.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be stored and protected in accordance with the manufacturer’s recommendations.

B. Plate packs shall be shipped on flatbed trucks to allow access by crane provided by the contractor.

C. If access by crane to the basins is not possible, then the plate settlers shall be shipped as a pack which can be disassembled for individual component installation.

1.5 QUALITY ASSURANCE

A. Manufacturer shall have available skilled installation, supervision and start-up services as specified.

B. Manufacturer shall provide an installation list of a minimum of 10 installations of similar design as specified herein installed within the last five (5) years.

1.6 GUARANTIES/WARRANTY

A. The manufacturer of the mechanical bar/filter screen shall guarantee all components provided by said manufacturer including buy-out items not manufactured by said manufacturer for a period of twelve (12) months, commencing from the date the equipment is put into service, or eighteen (18) months from delivery of the equipment, whichever is shortest.

1.7 MANUFACTURERS

A. Parkson – Aqua Guard

B. HUBER – EscaMax

C. Andritz – Aqua Clean

PART 2 - PRODUCTS

2.1 MECHANICAL PERFORATED PLATE SCREEN

A. The automatic perforated plate screen will be designed to positively clean and remove debris up to 3 inches in diameter from the influent stream by means of high impact plastic filter elements designed to retain and elevate debris to the discharge point of the unit where the rotating brush assembly cleans the elements.

B. The unit shall be suitable for installation and operation in a channel measuring four (4) feet wide and six (6) feet deep. There shall be a 3.5-inch recess (notch) in the channel bottom to accommodate the base of the screen. The angle of inclination shall be 75 degrees from horizontal. The opening from which the unit discharges screenings from its enclosure shall be approximately 11’ above the channel invert. Element size shall be 6 mm.

C. The screen shall be capable of passing a maximum peak flow of 12 MGD based on a nominal unit width of 4 feet, with a downstream water level of approximately 30 inches feet. The maximum upstream water level shall not exceed 34.7 inches with a clean screen. The maximum upstream water level shall not exceed 35.4 inches when the screen is 30% blinded.

1. Wastewater Influent TSS

a. Maximum Influent TSS = 508 mg/L
b. Average Influent TSS = 155 mg/L

D. The screen shall be capable of presenting a clean filtration surface to the influent stream at all times during continuous operation. It shall be capable of intermittent operation in order to form a mat of material to provide maximum trash removal. the screen shall have adequate contact surface area per square foot of wetted filtration belt frontal surface in order to maximize the capture of paper, rags, and other flexible debris, which tends to drape over and adhere to the filtration surfaces.

E. Washwater Requirements

1. 40 PSI at 24 GPM

2.2 FRAME

A. The frame of the unit, which is stationary, shall be constructed from type 304, stainless steel with a thickness of 3/16 inch. It supports and locates all of the operating components. The unit shall rest at the bottom of the channel, and be

anchored at the operating floor elevation. No mechanical mounting or fastening of the unit frame is required to the sidewalls or bottom of the channel.

B. The “A” frame unit shall be supported at the operating floor elevation by support legs constructed from type 304 stainless steel. The legs shall be designed to allow the unit to pivot the screen out of the channel without dewatering (e.g. for bypass purposes). Routine service of the unit is possible with the screen in the channel.

C. Guide rails shall be mounted to each side on the inside surface of the frame to direct the filter belt during its ascension out of the channel. The guide rails shall be 1/2 inch thick and will be constructed from type 304 stainless steel.

D. At the top of the screen, circular chain guides shall gently direct the filter belt from its ascending path out of the channel towards the drive sprockets. These circular guides shall be constructed from type 304 stainless steel and shall be welded to a type 304stainless steel shaft. In order to reduce the wear on both the chain and chain guides, the shaft shall be secured to bearings on each side of the frame and free to rotate.

E. Chain guides shall also be provided to direct the filter belt from the drive sprockets to the descending path into the channel. These fixed rails shall be constructed of type 304 stainless steel and shall be 5/8 inch thick.

F. Lower return guides shall be provided at the base of the screen to direct the filter belt during its 180-degree turn from the descending to ascending paths. The lower guide rails shall be constructed from 1/2-inch thick type 304 stainless steel and shall be fixed in place as low as possible in the frame to optimize the submerged screen area. No submerged bearing or rotating guides are used that will require routine maintenance or that may become fouled by trash and debris.

G. Neoprene rubber seals with type 304 stainless steel backing plates shall be mounted along the upstream edges of the frame to seal the outer edge of the frame against the channel wall, and the area between the frame and filter belt side plates.

H. The bottom of the unit shall be sealed with two rows of nylon brushes, which allow the elements to pass through, but prevents trash from passing beneath the filter elements, ensuring capture of all solids and trash by the filter belt.

I. All shaft bearings are mounted externally to the side frame for ease of access and maintenance.

J. The rear portion of the screen shall be equipped with covers to protect operators from contact with moving parts and minimize misting and dripping. All enclosures shall be removable. There shall be a hinged section for access to the screen and rotating brush assembly for periodic maintenance. The covers shall be fabricated from 14 gauge type 304 stainless steel.

2.3 FILTER/BELT SCREEN ASSEMBLY

A. The screen shall provide dual filtration of all materials in order to minimize compaction of captured debris and minimize the head loss through the screen. This

shall be accomplished by recessing the horizontal fine filtration opening in the face of the screen. The elements are arranged in a staggered fashion to form an endless belt and to create a range of motion that allows the recessed shank/arm of one row of elements to pass through the plane of the forward arm of the next row of elements it meshes with. Each filter element shall be a single molded component with a rake integral to its shape. The filter belt shall form a row of these rakes spaced every 4 inches, capable of lifting material of up to 3 inches in diameter out of the channel. The elements are secured to two separate filter shafts that pass through individual bosses in the elements.

B. The side plates (or end plates) are mounted next to the outermost elements of each filter row, and overlap to form a continuous moving sidewall for the filter belt. This moving wall prevents captured trash and debris from spilling over the sides of the filter belt. The side plates shall be constructed from a high strength phenolic resin.

C. The tension of the moving screen/filter belt assembly shall be completely supported by a stainless steel link chain. The chain must connect the filter shaft ends on both sides of the belt assembly so that the elements are free of tension, and support no weight of the assembly. The chain shall be of closed link design with 2 link sidebars, chain rollers and pins per link. The chain assembly shall have a minimum cross sectional area of 0.144 square inches at the weakest point of any individual link sidebar.

D. Chains shall be supplied with hollow pin construction that allows for the removal and replacement of the filter shafts, side plates and filter elements without releasing the chain tension. The unit is designed to allow this function to take place at the operating floor elevation with the screen in the channel. Chain rollers shall have a diameter of 1-3/4 inches.

E. All chain components shall be corrosion resistant stainless steel. Sidebars shall be type 304 stainless steel. Pins, bushings and rollers shall be type 400 series stainless steel. 400 series components shall be heat treated to a minimum hardness of 39 on the Rockwell C Scale.

F. The filter shafts shall have a maximum diameter of 3/4 inch and be spaced on 4-inch centers in the direction of travel of the filter belt. The shafts shall be constructed from type 304 stainless steel.

2.4 DRIVE ASSEMBLY

A. The drive assembly consists of a gear reducer, motor, drive shaft, and eccentric bearing. The drive mechanism shall be protected from the trash stream to ensure that the screen runs smoothly without jamming. The driving force is transmitted to clean, trash free components to avoid mis-tracking or binding, which could render the screen inoperable, requiring manual cleaning and realignment.

B. The gear reducer is of hollow shaft design by Sumitomo, mounted directly to the unit external to the side frame and connected directly to the drive shaft with a keyless tapered bushing. The reducer shall be designed in accordance with AGMA recommendations for Class II service based on the required horsepower for operation of the machine.

C. The **3/4** horsepower motor shall be a squirrel cage induction motor, TEFC, 460 volt, 3-phase, 60 Hz, 1800 RPM.

D. Overload protection shall be provided by an electrical overload device that senses motor current draw (SSAC Current Monitor or equal).

E. The filter belt drive shaft is located in the head of the unit and is supported at each end by the hollow shaft reducer and eccentric bearing. The drive shaft sprockets that engage the filter belt chain rollers and transmit motion to the filter belt assembly are welded to the drive shaft. The drive shaft and sprockets shall be constructed from type 304 stainless steel.

2.5 ROTATING BRUSH ASSEMBLY

A. The filter belt assembly is cleaned by the interaction of the filter elements and the rotating brush assembly without requiring any water or other mechanical devices capable of jamming (i.e. doctor blade) to remove the captured material.

B. The rotating brush assembly is supported by bearings on each side of the machine mounted externally to the machine frame. The brush is chain driven by the filter belt drive shaft.

C. The brush is comprised of two separate components, the brush shaft, and the brush core. The shaft is made of type 304 stainless steel. The brush core is made of UHMW, with tufted nylon bristles. The core is split into two halves that are fastened with stainless steel hardware to the brush shaft. This allows the brush to be easily removed from the machine simply by removing the hardware, and separating the core pieces from the shaft. To install a new brush, the two new core pieces are placed over the shaft, and the hardware is inserted through the factory holes and tightened.

D. The brush shall be orientated in a paddlewheel design with rows of bristles located at 90,180, 270, and 360 degrees.

2.6 DISCHARGE CHUTE

A. A discharge chute shall be provided integral to the machine, constructed from 14 gauge type 304 stainless steel and designed to direct the screenings to the collection equipment below.

B. The chute shall have a 1/4-inch thick flange that shall allow it to be connected to ancillary washing, compacting, and collection equipment.

2.7 LUBRICATION

A. Lubrication lines shall be extended from each bearing housing to a central point located on the respective side of the machine, accessible from the operating floor for ease of maintenance.

2.8 FASTENERS

A. All fasteners shall be type 316 stainless steel.

2.9 SURFACE FINISH

A. Surface treatment of stainless steel components.

1. All frame and structural members will be mechanically cleaned using Dupont Starblast. Sheet metal components such as covers or the discharge chute will be furnished with a 2B finish.
2. All other appurtenances including roller chain, brush sprockets, bearing housings, motor, reducer, etc. shall be supplied with the manufacturer's standard finish.

2.2 SCREENING WASHER/COMPACTOR

A. Design Data:

1. Maximum cubic feet of screenings per hour (continuous) – 35
2. Volume reduction, minimum – 60%
3. Minimum motor HP – 3
4. Solids content after compaction, minimum – 70%
5. Operational Environment – Class 1, Division 2
6. Screening wash water supply – 15 gpm @ 60 psig max.

2.3 MATERIALS OF CONSTRUCTION

A. The main body will consist of a drainage trough and a washer barrel, enclosed by an outer housing and a support leg at each end. The main body will be constructed of type 304L stainless steel for all welded components; to minimize corrosion in the heat affected zones, and type 304 stainless steel for all non-welded components.

B. The drainage trough will be the perforated inlet area of the unit, which captures screenings and allows liquid to drain. The drainage trough will be constructed from 12 gauge (0.11") for AWP 8 stainless steel with 0.19 inch diameter perforations.

C. The washer barrel will provide a washing zone and a dewatering zone for the incoming screenings. The washer barrel will be constructed of 0.25 inch thick stainless steel, with three distinct perforated drainage zones having 0.19 inch diameter holes chamfered to 0.38 inch diameter on the outside. The inside of the washer barrel will be provided with six (6) 0.25 inch thick by 1.50 inch wide replaceable wear bars with 400 Brinnel hardness.

1. The outer housing will enclose the sides and bottom of the drainage trough and washer barrel. The outer housing will collect drained liquid from the drainage trough and washer barrel and direct the liquid to a 4.0 inch drain tube. Access panels will be provided on the outer housing in the washer barrel area to facilitate servicing of the washer barrel. The outer housing will be

constructed from 10 gauge (0.135 inch) thick stainless steel.

2. A support leg will be provided at each end of the main body to support the main body, provide the means to mount the drive assembly (at the drive end), and provide the means to mount discharge piping (at the discharge end). Each support leg will be designed to allow the screw to be removed from either end of the main body. Each support leg will be provided with a footpad and anchor bolt holes, to secure the unit to the structure
3. The shafted screw will be provided to convey screenings through the various stages of the unit. The screw will be constructed of carbon steel and finished with alkyd enamel paint. The spiral will be a minimum of 8.00 inches OD and have minimum 0.63 inch thick flights. A replaceable 0.25 inch wide nylon brush with a stainless steel casing will be attached with bolted clips to the spiral OD throughout the inlet area to scour the perforated sheet. The brush OD will be 8.50 inches.
4. The wash zone will include a spray wash system to wash organic residue from screenings. The wash zone spray will consist of one (1) spray header, four (4) water injection points, one (1) ball valve and one (1) solenoid valve. The solenoid valve body will be of brass construction with Buna seals. The ball valve will be of brass construction with a stainless steel ball. The system will have an output of 10 GPM at 60 psi. The spray connection will be ½ inch NPT.
5. The press will include a single point spray wash system to flush organic residue trapped in the outer trough. The flushing spray will consist of one (1) spray header, one (1) ball valve and one (1) solenoid valve. The solenoid valve body will be of brass construction with Buna seals. The ball valve will be of brass construction with a stainless steel ball. The system will have an output of 15 GPM at 60 psi. The spray connection will be ½ inch NPT.

2.4 DRIVE SYSTEM

A. The unit drive system will consist of a gearmotor mounted on a sealed drive mounting bracket and a drive shaft that connects the gear reducer output to the shaft of the screw.

B. The gearmotor will be a single speed, dual voltage SEW Eurodrive motor direct coupled to an SEW Eurodrive helical gear reducer.

1. The electric motor will be a 3 horsepower for severe duty motor with a 1.15 service factor, rated for use in a 40° C ambient temperature. The TEFC motor will be NEMA design B with Class F insulation, 1800 rpm output speed, and a 230/460 volt, 3-phase, 60 Hz power supply. The motor conduit box will have one (1) 1/2 inch NPT and one (1) 3/4" NPT conduit connection.

    a. The gear reducer will be AGMA class II (1.6 service factor) with a minimum 94% efficiency, producing an output speed of 14 rpm and an output torque of 13,900 inch-pounds. Heavy duty tapered roller bearings in the gear reducer will provide a maximum thrust capacity of 6,740 pounds.
    b. Gear reducers with service factors of less than 1.4 and efficiencies of less than 94% will not be allowed.

2. A drive mounting bracket will be provided to mount the gearmotor to the drive

end support leg of the unit. The bracket will be made of type 304L stainless steel.

3. A compression type packing gland seal will be provided on the mounting bracket to seal the drive shaft. PTFE packing rings will be fitted into the seal housing, and held in place by a two-bolt stainless steel gland follower.
4. The drive shaft will be direct coupled to the spiral and constructed of carbon steel. The shaft will be painted, except in the area of the shaft that extends into the hollow bore of the reducer.
5. Inlet Hopper and Cover

    a. A 12 gauge (0.105 inch) stainless steel inlet hopper will be supplied to direct screenings and liquid into the drainage trough. The chute will be flange bolted to the trough, with each side of the chute being a minimum 60 degrees from horizontal.
    b. A 12 gauge (0.105 inch) stainless steel cover will be supplied to cover the remaining top of the main body.
    c. A gasket will be provided to seal the feed hopper's inspection door cover.

1. A 14 gauge (.075 inch) stainless steel discharge pipe will be fitted to the discharge end support leg to direct screenings into a customer provided receptacle. All discharge pipe flanges will be 304L stainless steel. Aluminum flanges will not be allowed.
2. Pipe supports if need shall be supplied by the supplier.
3. All fasteners shall be 316 stainless steel

2.5 FABRICATION

A. Weld size, type, and procedure will provide the necessary strength and facilitate the manufacturing of the specific component.

2.6 SURFACE FINISH

A. All stainless steel components will have standard mill finish and will be mechanically cleaned to remove weld discoloration and fabrication markings.

B. The screw and drive shaft will be finished with an enamel coating.

C. The motor and gear reducer will have the standard manufacturer's finish.

2.7 ELECTRICAL DEVICES AND CONTROLS

A. Electrical device interconnecting conduit and wiring will be the responsibility of the installing contractor. In addition to the drive motor, the following electrical devices will be furnished with the unit:

1. Two (2) 120 volt, single phase, 60 Hz solenoid valves for the wash zone and flush spray washes housed in NEMA 7 enclosures will have 18-inch long integral leads and will have 1/2 inch NPT conduit connections.

2. A NEMA 7 polycarbonate emergency stop push button will be mounted to the end flange and will have a 1/2 inch NPT conduit connection.

B. Control Panel

1. One (1) control panel shall be provided for control of the screen and compactor.
2. Refer to Specification Section 26 29 00 “Manufactured Control Panels” for additional requirements.
3. The screen control panel shall meet or exceed the existing control functions and auxiliary items included on the existing screen control panel to be replaced.
4. The equipment manufacturer shall be responsible for the proper sizing and operation of the control equipment to adequately protect and control the screening system equipment.
5. The single control enclosure shall be of:

    1) NEMA 4X stainless steel construction
    2) Sufficient size to contain all controls for the screening equipment.

6. Control panel shall be UL listed.
7. Controls shall include, but not be limited to, a disconnect, starters and MCPs for screen drive, brush and compactor, transformer, fuses, fuse block, HOA switch for belt drive, brush and compactor, repeat cycle timer, liquid level timer, running (green) and alarm (amber) indicator lights for each motor, float switch level sensor (for back up), High Differential Level Alarm indicator light (amber), Backup Float High Level Alarm indicator light (amber), two ultrasonic level indicators (one upstream and one downstream of the screen), ultrasonic differential level controller (mounted within control panel, to be accessible from front of dead-front panel door), and all appurtenances for a complete operational system.
8. Ultrasonic level indicators shall be Siemens HydroRanger 200 with Echomax ST-H transducers.
9. Necessary relays shall be included to annunciate status and alarm conditions.
10. Normally open contacts shall be provided for the purpose of indicating such conditions at the remote status panel location.
11. Dry contacts and other provisions as required to provide I/O to/from the plant SCADA system per the SCADA point lists shown on plans.
12. A NEMA 7 weatherproof emergency pushbutton station shall be mounted to the frame of the unit.
13. A NEMA 7 rated, weatherproof, 120 V, SINGLE PHASE, 60 hertz normally closed solenoid valve shall be provided to actuate the cleaning system.

C. Supplier is responsible for coordinating and including all instrumentation necessary for the operation and/or control of the screen equipment.

2.8 TESTING

A. The screen shall be:

1. Factory assembled and tested for a minimum of 1 hour prior to delivery.
2. Delivered to the job site fully assembled.

2.9 HEAT TRACING

A. Heat tracing shall have a minimum design temperature for 16°F and a maintenance temperature of 40°F.

B. The compactor and discharge chute shall be heat traced and insulated by the screen manufacturer in accordance with the requirements listed in this specification.

C. Heat tracing system shall consist of the following components for each compactor and discharge chute:

1. 60-feet of self-regulating cable, nominal 5 watts per foot output, 120 V (see Specification Section 26 44 00).
2. 1 – Control thermostat with adjustable set point to turn power to cable on and off (see Specification Section 26 44 00).
3. 1 – Power connection (see Specification Section 26 44 00).
4. 1 – End splice with lighted end seal kit/indicator light (see Specification Section 26 44 00).
5. All devices/components/installation in accordance with NEC requirements for Class I, Division II hazardous areas.
6. 1 – Roll of aluminum installation tape (Raychem AT-180).
7. Stainless steel installation pins (quantity to be determined by manufacturer).
8. Mineral wool and/or fiberglass insulation, nominal 2-inch thickness, maximum k value of 0.3 (BT in.)/hr. °F ft^2).
9. A removable insulation blanket consisting of nominal 1-inch thick fiber insulation core enclosed in silicone coated cloth.
10. Non-corrosive wire and clips to hold removable blankets in place.
11. Embossed stainless steel insulating jacketing.
12. Stainless steel hardware and straps as required to hold metal jacketing in place.
13. Silicone caulk to seal jacketing joints as required.

D. Heat tracing system shall be installed as follows:

1. Install heat cable starting from power connection along drainer shower pipe including the solenoid. Fix cable in place using glass installation tape.
2. Install heat cable along lower 1/3 of RPS trough bottom to drive end, then turn 180 degrees and run cable along bottom of trough and continue along bottom of drain pipe up to compactor section. Use metal tape, continuous layer to affix cable to trough and drain pipe.
3. At the compactor end, affix cable to compactor section shower piping and solenoid using glass installation tape. Loop cable around solenoid body two times. Make sure to also affix cable to small diameter piping loop.
4. Run cable along bottom of RPS trough back towards drive end and then along remaining drainer shower pipe to the end splice.
5. Terminate cable ends per instructions of the end splice manufacturer.
6. Install fixed insulation using weld pins on RPS trough and drain pipe.
7. Insulate the drive end lower half of trough and enclose complete drain pipe.
8. Insulate trough to within 2 inches of top flange to allow removal of covers.
9. Stop insulation minimum of 2 inches from side covers.
10. Install embossed aluminum or stainless steel jacketing to cover fixed insulation and use stainless steel hardware and straps to secure jacketing in place.

11. All jacketing to be installed in a workmanlike manner.
12. Jacketing to have drain holes at low points to allow water to drain freely from behind jacketing. Jacketing is to be installed to deflect rain water and wash water from insulation.
13. Install removable blankets over compactor and drainer shower piping leaving solenoid coils un-insulated (solenoid valve bodies are insulated). Install single layer of blankets that are 2 inches thick. Install double layers if blanket is only 1 inch thick.
14. Install removable blankets on compactor trough covers overlapping on the sides to match with the jacketing.
15. Install removable blankets over access doors.
16. Removable blankets are to be held in place using non-corrosive wire and clips or other suitable method.

E. Manufacturer shall supply 30-feet of additional heat tracing equipment as described here within for 1-inch pipe. This shall be supplied from the screen control panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Owner, for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

3.2 STARTUP AND TESTING

A. Self-cleaning bar-filter media, channel screen

1. After completion of installation, the equipment shall be inspected certified by a representative of the manufacturer as being in compliance with the manufacturer's recommendations and requirements.
2. After such inspection, the equipment shall be given any required adjustment and, when complete, the various items of equipment shall be placed into operation under the supervision of the manufacturer's representative.
3. A minimum of 1 trip for a total of 2 days shall be provided to accomplish these services.

END OF SECTION 44 42 26

SECTION 44 42 28 – SEPTAGE RECEIVING STATION

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes requirements for providing the following equipment:

1. Septage Receiving Station

1.2 SUBMITTALS

A. Certification from Contractor and Manufacturer/Suppliers: During the bid period and again prior to submitting/ordering and installing materials, products and equipment, the Contractor and all manufacturers and suppliers shall thoroughly review the materials, products and equipment being supplied and shall familiarize themselves with the existing and proposed/new facilities, as well as connections to existing facilities/utilities. This shall include field verification of the location, nature, size/dimensions, current and intended future use, etc. Prior to ordering and installation, the Contractor shall coordinate with all manufacturers and suppliers to provide all needed information including field dimensions, photographs, information on related materials and equipment, etc.). The Contractor and all manufacturers and suppliers shall include written confirmation (with the submittal) of the following:

1. The materials, products, and equipment being supplied are of the correct size, materials and type.
2. The materials, products and equipment being supplied do not conflict with existing or proposed/new facilities.
3. The products/equipment being supplied are intended for use in this application.
4. All manufacturer(s) and supplier(s) shall provide (either with submittals or separately) written concurrence/acknowledgement of their review/coordination and concurrence with the items above.
5. Shop drawings and product data submitted for review by the Engineer shall bear the Contractor's certification that he has reviewed, checked, and approved the submittals, that they comply with the requirements of the project and with the provisions of the Contract Documents, and that he has verified all sizes, dimensions, locations, field measurements, construction criteria, materials, catalog numbers, and similar data. Field dimensions, sizes and other pertinent information shall be clearly shown on the shop drawings/submittals. The Contractor shall also certify that the work represented by the shop drawings is recommended by the Contractor and that the Contractor's warranty and guarantee will fully apply.

B. Product data including rated capacities, accessories, details of construction relative to materials, dimensions of individual components, profiles, finishes, description of all materials, complete bill of materials, complete motor data, performance data, operational and maintenance data, and any other pertinent information.

C. Shop Drawings:

1. Drawings showing complete dimensional data, mounting details, motor locations, instrument locations, and assembly information.

D. Maintenance Data: Septage receiving systems shall include the maintenance manuals specified in Division 1. Include name, address, and telephone number of manufacturer's nearest authorized service representative.

1.3 QUALITY ASSURANCE

A. Identification: Equipment shall be provided with a corrosion resistant nameplate which shall contain at a minimum the manufactures name and address, equipment model number and serial number.

B. Manufacturer, at request, shall provide a list of reference sites for similar equipment installations for verification by the Engineer.

C. Manufacturer shall conduct factory testing and verification prior to shipment.

D. Source Limitations: Obtain septage receiving system as a complete unit from one source.

E. Unit shall be fully assembled and shop tested to confirm fit and function of the unit. A certificate of the shop test shall be supplied with the shipping documents. Ancillary components may be removed to prevent damage during shipment.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store septage receiving equipment in a manner to avoid significant or permanent damage to equipment.

1. In general comply with manufacturers written instructions for storage of equipment.
2. The septage receiving equipment shall be stored in a clean, dry location free from construction dust, precipitation and excess moisture.

1.5 WARRANTY

A. Warranty Period: One year from date of Substantial Completion

1. Warranty shall be for unlimited usage of the equipment for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Septage Receiving System

a. SAVI Beast Septage Station, Model VFA-800-DM, as supplied by SAVÉCO North America, Inc.
b. Or approved equal.

2.2 SEPTAGE RECEIVING SYSTEM

A. General

1. The septage receiving system shall effectively separate, wash and dewater septic waste that has been delivered to the system. It shall be a fully automatic, self-cleaning unit incorporating a perforated plate rotating drum screen and an integral screenings washing, conveying and dewatering/compacting system contained within a stainless steel tank. The tank mounted rotating drum screen unit will be provided with an angle-of-inclination of 25˚ from horizontal.

2. The septage receiving system shall include the hauler station, flow meter, and Flo-Logic Software Package.

B. Performance

1. The septage receiving system shall wash, compact the screenings, and discharge to a dumpster. A grinder or rock trap should **not** be included with the system.

Conditions	Unit
Number of units	One (1)
Influent Type	Municipal Septage
Influent Solids Concentration (mg/l)	3-4%
Design Flow per unit (gpm)	300-400
Peak Flow Capacity per unit (gpm)	450
Perforation Size (mm)	6
Drum Basket Nominal Diameter (inches)	30
Inlet Connection	4-inch flanged
Outlet Connection	8-inch flanged
Beast discharge height from operating level (feet)	4.9
Drum Installation Angle	25°
Drum Motor HP	1.5
Screw Motor HP	2.0

C. Design Requirements

1. General

a. Equipment provided shall be a fully automatic, self-cleaning receiving unit incorporating a perforated plate rotating drum screen and an integral screenings washing, conveying and dewatering/compacting system contained within a stainless steel tank. The tank mounted rotating drum screen unit will be provided with an angle-of-inclination of 25˚ from horizontal.
b. Each rotating drum screen unit shall be provided with a rotating screen basket, exterior basket cleaning spray bar(s), exterior basket cleaning brush,

concentric transport screw with integral screenings washing, dewatering and screenings compaction zone.

c. All parts and assemblies shall be fabricated using type 304 stainless steel unless otherwise noted.
d. Electrical motors/devices on the Septage Receiving process equipment shall be rated for hazardous locations per NFPA 820 requirements.

2. Rotating Drum Screen Basket

a. The Drum Screen Basket shall be designed and built to withstand the maximum possible static hydraulic forces exerted on the screen by the liquid flow. Structural and functional parts shall be sized to prevent deflections or vibrations that may impair the screening, conveying, washing and compacting operations.
b. The drum screen basket shall be mounted at the drive end using a large diameter, single row, heavy duty industrial bearing assembly with integral ring gear comprising part of the drive system. The bearing assembly shall have a built in grease fitting.
c. The drum screen basket shall be of a cylindrical shape with perforations around the entire basket.
d. The drum screen basket shall be perforated plate with maximum openings of 6 mm. Bar screens, wire mesh or wedge wire, or stationary screens of any type will not be acceptable screen media.
e. The drum screen basket shall have angled lifting vanes to retain loose solids during rotation and lift them up and into the screw auger trough. Helical shaped vanes which can tumble screenings rather than lift screenings shall not be accepted.
f. The screenings collection trough shall extend beyond the screen opening at the influent end to maximize solids capture and reduce screenings recycle.
g. The drum screen shall have no support arms on the influent side of the screen basket to snag and accumulate long stringy solids. Screens with influent side support arms will not be accepted.
h. The drum screen basket shall be provided with a seal system incorporating an HDPE seal. Any unit which does not incorporate this design will not be accepted.

3. Drum Screen Basket Cleaning Brush and Spray Bar(s)

a. The exterior of the rotating drum screen basket assembly shall be cleaned by a high pressure stainless steel spray bar and a stainless steel backed polypropylene brush. The drum screen basket shall continuously rotate in one direction during the cleaning cycle and pass through the topmost portion where it is cleaned by the spray bar and brush.
b. The exterior cleaning brush shall be mounted on a holding device which keeps the brush in constant contact with the screen basket and can be adjusted to compensate for brush wear.

4. Screenings Transport Screw and Dewatering Zone

a. The screenings transport screw shall be constructed of an epoxy coated high strength alloy steel for maximum torsion resistance in the screw. The screw shall be near-white blasted, primed with an inorganic zinc primer and coated with a 2 part epoxy.
b. The screenings collection trough shall be attached to the screenings transport tube by a drum support flange. The screw drive assembly shall be attached via a drive support flange welded to the upper end of the screenings transport tube.
c. The concentric transport/dewatering screw shall be designed to transport and dewater the screened material. The unit shall be provided with screw flights of constant pitch approaching the compaction zone to prevent clogging in the compaction zone. Designs incorporating a decreasing pitch screw will not be accepted.
d. The screenings transport screw shall be supported by a sealed, self-lubricating lower bronze bushing. The lower bushing shall be designed such that it does not take any thrust load from the transport screw. Designs requiring bearings of any type or externally lubricated bushing(s) or water injection into the housing shall not be accepted.
e. The compaction zone shall be integral to the transport screw and compaction tube. The compaction zone shall be designed to form a screenings plug and return water released from the screened material back to the tank through circular holes that are machined into the screenings compaction tube.
f. The compaction zone housing shall be fabricated entirely of stainless steel. The lower body shall be a welded construction with a minimum of 10 mm end plates for maximum torsion resistance. The bottom of the compaction zone shall be curved to promote maximum cleaning and minimum depositing of materials. Units utilizing a fiberglass reinforced compaction zone housing will not be accepted.
g. The compaction zone shall be furnished with a latched, hinged access cover with a gasket. The access cover shall incorporate a safety interlock switch to prevent operation of the unit with the access cover open. Units which require the use of any tools to gain access to the compaction zone will not be accepted.

5. Spray Wash Systems

a. Drum and flush spray systems shall each be furnished with an automatically controlled electrically actuated full port stainless steel ball valve, stainless steel piping and fittings, flexible reinforced hoses and spray nozzles.
b. Compaction zone spray system shall be furnished with a control solenoid valve, stainless steel piping and fittings, flexible reinforced hoses and spray system.
c. A drum wash system shall be located over the rotating perforated drum which utilizes a spray bar(s) with adequate spray nozzles to ensure a consistent spray pattern over the entire length of the drum.
d. A screenings spray wash system shall be located in the lower section of the transport tube to break up and return organic materials to the flow stream and to ensure maximum screenings washing.
e. A compaction zone wash system shall be provided which periodically cleans the compaction and dewatering zone via a stainless steel wash system located in the uppermost end of the compaction/dewatering chamber. The

header shall be designed to completely wash the full surface of the transport tube drainage area.

6. Screen Tank

    a. The septage receiving unit shall be supplied with a two-stage stainless steel tank. The bottom of the influent section of the tank shall be sloped toward the screen to eliminate sedimentation. The inlet section shall be sized to match the inlet shape of the drum to prevent a wall for solids to dam and collect. Units with rectangular tanks which encourage sedimentation shall not be accepted.
    b. The second stage tank shall house the rotating drum screen unit.
    c. The inlet stage of the tank shall be provided with a flush wash system.

7. Drive Units

    a. The septage receiving unit shall be a dual drive system which allows the drum and screw to be driven independently to optimize solids removal.
    b. Gear reducers shall be a helical gear type as manufactured by NORD or approved equal. Provide a cast iron frame; design in accordance with AGMA recommendations for wastewater service.
    c. Transport screw shall be directly driven by a flange mounted gear reducer.
    d. The transport screw gear reducer shall be bolted to a machined flange welded to the upper end of the transport tube.
    e. The rotating screen drum basket shall be driven by a flange mounted gear reducer using a spur gear and bull gear assembly.
    f. Gear reducers shall be driven by 240/480V, 3 ph, 60 hz motors rated for the installation environment location.
    g. Chain drives, belt drives, friction drives, or hydraulic drives will not be accepted.
    h. Designs incorporating a separate upper bearing for the transport screw will not be accepted.

8. Drum Retraction

    a. The complete screen assembly must be able to be retracted away from the front seal plate to allow for replacement of the seal without pivoting the screen or requiring lifting devices such as cranes or come along hoists.
    b. Units that require pivoting of the screen for seal replacement shall be required to provide a complete workable lifting system.

9. Pivot Assembly

    a. The complete screen assembly must be able to pivot out of the tank without requiring the removal of the drive unit, screw or drum. Units that require disassembly of the unit shall not be allowed.

D. Inlet Connection

1. Provide a 4-inch aluminum male cam and grove style inlet connection with removable cap.

G. Tank Assembly

1. Tank shall have a class 150 4-inch inlet flange.
2. Tank shall have an 8-inch straight pipe discharge.
3. Tank shall be constructed of passivated 304 stainless steel.
4. Tank shall include lifting points for slings and forklift forks.
5. Tank shall include mounting points for spray wash assemblies.
6. Tank shall have a removable cover.

H. Spray Wash Assemblies

1. Piping and fittings shall be constructed of 304 stainless steel.
2. Spray nozzles shall be constructed of 303 stainless steel.
3. Exposed spray wash piping shall be insulated and heat traced.
4. Solenoid valves shall be brass body construction with a 120 volt AC coil and shall be suitable for Class I, Division 2, Group D hazardous area.
5. Manual ball valves shall be constructed of 304 stainless steel.

I. Inclined Screw Conveyor

1. Perforated/Bar Screen Trough

    a. Screen shall be constructed of 304 stainless steel and polished to remove burrs.
    b. Perforations shall be maximum ¼-inch in diameter.

2. Transport Tube Assembly

    a. Transport tube shall be constructed of passivated 304 stainless steel.
    b. The transport tube shall have 304 stainless steel flanges for attachment to the screen and the dewatering zone.

3. Dewatering Zone

    a. The dewatering zone shall be constructed of passivated 304 stainless steel.
    b. Dewatering zone shall be dual compartment design.

4. Motor

    a. The motor shall be manufactured by TECO, WEG, or approved equivalent.
    b. The Motor shall be 2 hp, TEFC, 1725 rpm, 230/460 volt, 3 phase, 60 Hz.
    c. Motor shall have a minimum service factor of 1.15, 84% minimum efficiency factor full load, minimum 81% power factor at full load.

J. Controller

1. Enclosure

a. Main enclosure shall be 316 stainless steel NEMA 4x and house the control devices, motor starters, emergency stop and PLC.

2. Start & Stop Pushbuttons

a. Pushbuttons shall be rated NEMA 4x.
b. Start pushbutton shall initiate operation of the system.
c. Stop pushbutton shall initiate a stop of the system and immediately stop the grinder motor and close the pinch valve. The tank spray wash solenoid shall energize and operate along with the auger motor and auger spray wash for the duration of the cleaning cycle.

3. Grinder

a. A grinder is not being provided with this scope of supply, however, the control panel shall have provisions for adding a grinder to the system in the future.

4. Auger ON/OFF/AUTO Selector Switch

a. In the ON position, the auger shall run continuously.
b. In the AUTO position, the auger shall be controlled by the START and STOP pushbuttons.

5. Pinch Valve OPEN/CLOSE/AUTO Selector Switch

a. In the OPEN position, the valve will open.
b. In the CLOSE position, the valve will close.
c. In the AUTO position, the valve will be controlled by the ultrasonic level sensor mounted on the tank.

6. RESET Switch

a. Reset switch shall be NEMA 4X
b. Reset switch shall clear any fault condition and shall reset the system for normal operation.

7. Pilot Lights

a. Lights shall be LED type rated NEMA 4X.
b. Lights shall indicate AUGER RUN, PINCH VALVE OPEN, and FAIL.

8. Emergency Stop Pushbutton

a. Emergency Stop Pushbutton shall be rated NEMA 4X.
b. When activated, Emergency Stop shall close the plug valve, stop all motors and de-energize solenoid valves.

K. Electrical Controls and Devices

1. Control Panel: 480 volt- 3 phase primary control panel shall be provided with a type 304, stainless steel, NEMA 4X enclosure. Refer to Specification Section 26 29 00 (“Manufactured Control Panels”) for additional control panel requirements. Panel shall be suitable for wall mounting with the following electrical components to provide proper operation of the equipment:
    a. Main disconnect with through door interlock handle
    b. Step down control transformer
    c. Branch circuit protection
    d. Motor starter, soft start w/ overload (drum motor)
    e. Motor starter, reversing w/ overload (screw motor)
    f. Emergency stop pushbutton
    g. Hand-Off-Auto selector switches for drum and screw drive
    h. Open-Close-Auto switches for screen drum and tank flush wash water electrically actuated ball valves
    i. Open-Close-Auto switch for compaction zone wash water solenoid valve
    j. Load monitors shall provide overload protection for drum and screw by sensing motor power factor
    k. Hour meter for each motor
    l. Control power on, run and fault indicating lights
    m. Alarm reset pushbutton
    n. Allen-Bradley Micro 800 series PLC with Ethernet and required IO.
    o. Operator Interface Unit, Allen Bradley PanelView 800 with 4 inch screen
    p. Run and alarm auxiliary dry contacts for each motor (Drum motor and Auger motor) and auxiliary dry contact for High Level/General Alarm, for use by the customer (for SCADA monitoring) as shown on electrical plans.
    q. Intrinsically safe conductivity liquid level control relay
    r. Panel Heater, with Thermostat
    s. UL508A

2. Safety Microswitch: One (1) safety interlock switch suitable for the area classification shall be factory mounted to the compaction/discharge zone access door. Interlock switch shall prevent operation of the screen while the door is open.
3. Electrically Actuated Ball Valves: Provide two (2) electrically actuated full port 316 stainless steel ball valve to control flow to the drum spray wash and tank flush assemblies. The full port ball valve shall be 2-piece body, threaded ends, cast body from CF8M, 316 stainless steel, ball and stem from 316 stainless steel, and RTFE seats. Each valve shall be controlled by a weatherproof NEMA 7/4X electric actuator with a housing from cast aluminum with thermally bonded polyester power coating, stainless steel output shaft, stainless steel fasteners, 120 volt, single phase, 60 Hz, two SPDT limit switches, and visual indication on valve position.
4. Solenoid Valve: Provide one (1) weatherproof NEMA 7/4X solenoid valve to control flow to the compaction zone spray wash assembly. Valve shall have a brass body. Valve shall be 120 volt, single phase, 60 Hz.
5. Level Control: Provide one (1) non-contacting radar transmitter for operation of the unit by screen start level and high level. Unit shall not be affected by FOG, debris or foam. The radar unit shall provide a 4-20mA level signal and be rated for installation in a Class 1, Div. 1/Div. 2 area when using an intrinsically safe circuit. The sensor shall be supplied with 33 feet of integral cable.
6. Inlet Pinch Valve: Provide one (1) 4-inch inlet pinch-type valve for controlling flow into the unit. Pinch valve to be Red Valve Type A, full port design with cast iron body, ANSI Class 125/150 flanges and Buna-N elastomers. One (1) ½-inch 3-way

brass body solenoid valve to control pinch valve operation, suitable for 120 VAC operation with electrical rating as noted on Plan Sheet E9-01, Note 2.1. (Shipped loose)

L. Heat Tracing/Freeze Protection

1. The wash water lines shall be fitted with 120V, single phase, 60 Hz flexible self-regulating heat tracing wire and covered with a transport tube custom fitted insulation blanket. Heat tracing shall be rated for Class 1, Division 2 application. Refer to specification section 26 44 00 for additional requirements.
2. Compaction zone with heat pad and with custom stainless steel cover.
3. Transition between influent tank and main tank shall be heated with two (2) heat pads, insulation and protective 304 stainless covers.
4. Wiring from the wash water heat trace cables shall terminate in a factory mounted junction box for field connection by contractor.
5. The control panel shall include integrated heat trace circuits rated for the appropriate wattage as determined by the manufacturer.
6. GFCI-EPD (30mA ground fault trip) circuit breaker(s) shall be provided within the control panel as required to power the heat tracing and heat pad circuit(s).
7. One (1) ambient temperature thermostat shall be provided to control power to the heat trace cable. The thermostat shall be 120 Volt, single phase, 60 Hz with a NEMA 7/4X housing. The temperature set point shall be selectable by an adjustable dial.
8. Provide lighted end seal kit for all heat tracing system per specification section 26 44 00 requirements.

M. Hauler Access Station

1. Panel shall include the following components:
    a. Power Required: 120VAC, 5A
    b. Enclosure, NEMA 4X 304 Stainless Steel, 24” x 24”, with interior door and sub-panel
    c. Heavy Duty Key Lockable enclosure handle, with 3 Point door mechanism
    d. Panel Heater Kit, Heavy Duty with Thermostat
    e. Keypad, Stainless Steel, USB Type.
    f. User Display, Stainless Steel Bezel, Full Color, 1000 NIT Brightness.
    g. Thermal Printer, Large Capacity paper roll and feeder, with illuminated print done chute.
    h. Power Supply, 24 VDC.
    i. Communication Controller, Solid State Storage, Dual LAN.
    j. Provide Ethernet switch with 50-micro OM4 multi-mode fiber optic ports, and a fiber optic patch panel as required for remote network monitoring of the Hauler Station and as indicated on the Plant Network Diagram on electrical plans.
    k. Local I/O Control as required.
    l. UL Label, Industrial Control Assembly.

2. The manufacturer shall provide a secured Hauler Access Station that shall identify waste haulers and be configurable to interface with associated equipment such as doors, gates, valves, samplers, and screens & washers.

3. Hauler access shall be established using a keypad, non- insertion proximity card, or long-range proximity card.
4. The Hauler Access Station shall be constructed with an outer door that can be closed to enable a wash down of the area without damaging the internal mounted devices.
5. The hauler can access the station by opening the door to the enclosure and entering a truck ID number using the keypad or by using an assigned card. The card type shall be non-insertion proximity card.
6. If additional security measures are required by the facility, haulers shall use an additional card or pin number to access the front gate or door of the facility.
7. The Hauler Access Station shall include a daylight visible display and outdoor-rated robust keypad. The display shall provide log-on instructions for the hauler and prompt the hauler for additional information as required.
8. The Hauler Access Station shall include a receipt printer and integral light. The printer shall quickly print and cut each receipt and the integral light shall inform the hauler that a receipt has been printed.
9. Each printed receipt shall include the following:

    a. Date and Time of Transaction
    b. Station ID and Ticket Number
    c. Hauler ID number
    d. Volume Unloaded
    e. Elapsed Time
    f. Alarm ID
    g. Waste Type

10. The Hauler Access Station shall continue to function normally even without a network connection to the office. All hauler transaction data shall be stored in a local solid state drive. If a network connection is established, all transaction data shall be automatically synchronized and stored securely in an IT managed SQL database.

N. FLOW METER

1. One (1) ABB (or approved equal) 4-inch Flow meter, Hard Rubber liner, Hastelloy C-4 measuring electrodes, carbon steel Class 150 ANSI flanges, stainless steel grounding rings, ½-inch NPT conduit entry, HART, 20mA, or Pulse output signal types, suitable for Class I, Division 2, Group D hazardous area with integral mount transmitter. (Shipped loose).

O. SOFTWARE

1. The software shall monitor the Hauler Access Station(s) and automatically upload hauler transaction data. The Hauler station shall be remotely monitored over the specified fiber optic network connections as shown on the Plant Network Diagram. Provide all hardware, software, integration, etc. for a fully-functional remote monitoring system (at the Administration Building, using existing owner-furnished computer workstations).

2. An unlimited number of users shall have access to the Flo-Logic web interface for hauler and data management.
3. The data from each hauler transaction shall be collected and stored in a secure SQL database. The following data shall be collected:

    a. Site ID
    b. Station ID
    c. Ticket Number
    d. Hauler ID
    e. Date and Time of Transaction
    f. Volume Unloaded
    g. Additional Process Analyzer Data (if configured)
    h. Product Type ID
    i. Alarm ID
    j. Five (5) additional fields will be available for the administrator to define

4. The software shall be used to configure the hauler's identification method as well as their PIN used at the Hauler Access Station(s).

5. The software shall be used to configure scalable devices communicating with the Hauler Access Station(s), such as: flow meters, pH analyzers, conductivity sensors, acoustic sensors, and others.
6. The software shall allow the facility to periodically initiate an automatic sampler. Samples can be taken automatically for each transaction or periodically for selected trucks. The software will collect data to show specifically which loads were sampled.
7. A user-friendly interface shall be provided to allow the facility to view hauler transaction data and enter/edit information when necessary. The software shall have a built in sorting tool that allows the user to create multiple data views. The software shall have a "Main Screen" view that displays all transaction data divided into the following sections:
    a. Transaction Log
    b. Customers
    c. Truck Status
    d. Customer Balances
    e. Link to Reports

8. The software shall allow the facility to define the Hauler Access Station's operating time schedule. If the station is closed, a message will alert the hauler that the station is closed.
9. Customer (Hauler) and Truck Features:

    a. The software shall allow the facility to create a list of customers that will be billed for use of the Hauler Access Station(s). The software shall not limit the facility as to the number of customer accounts that can be created.
    b. The software shall allow the facility to create multiple truck accounts and link these accounts to the corresponding customers. The software shall not limit the facility as to the number of trucks that can be assigned to each customer.

c. The facility shall be able to enter customer ID numbers, pin numbers, and details regarding the truck including capacity, weight, and vehicle information into the system.
d. Each customer shall receive a Hauler ID number and 4-digit PIN number for each truck. PIN number assignment can be unique per owned truck or common to all owned trucks, depending on the facility and customer preference. The software shall auto-generate customer PIN numbers or shall allow the administrator to manually assign pin numbers to customers.
e. The software shall allow the facility to enable or disable a truck's access privilege. Once disabled, a hauler's access will immediately be denied at all sites. A message shall be displayed at log-in at the hauler station informing the hauler to contact the office.

10. Waste Type Features:

a. The software shall allow the facility to define a list of permitted waste types and an associated rate to be charged per 1000 units of waste unloaded. The software shall allow the facility to define these units. (Gallons, Liters, etc…) The facility shall also be able to set different rates for the same waste type. (Ex. Charging In-county/city customer vs. out-of-county/city customer).
b. When accessing the station, the customer shall be prompted at log-in to identify the waste type that shall be unloaded.

11. Status and Alarm Features:

a. The software shall allow the facility to monitor the Hauler Access Station in real-time. The facility shall be able to monitor the current customers/trucks total flow, waste types, valve status, equipment faults, and additional user-defined variables.
b. The software shall allow the facility to monitor alarms at the Hauler Access Station. Alarms make the station unusable or may prevent a hauler from unloading. These alarms include:
    i. E-Stop pressed
c. Printer Low on Paper
d. Equipment Fault
e. Storage Tank at High Level
f. Optional User-Defined Alarm (20 Available)

12. Reporting, Billing, and Payment Features:

a. The software shall allow the facility to manage each customer on a debit or credit basis. The facility shall choose whether customers shall pay prior to using the Hauler Access Station or after.
b. The software shall debit account balances automatically and auto-deactivate the truck's access privilege should the customer's balance drop below the set minimum. The facility shall be able to set the minimum.
c. The software shall allow the facility to bill on a truck capacity basis, a metered basis (flow-meter or scale), or by manual entry.

d. The software shall allow the facility to enter payments if required. The total balance shall automatically recalculate once a payment is applied. A customer's account that is deactivated shall be automatically reactivated once money is received.
e. The facility shall be able to use the features of the software to substantiate the data recorded from each transaction and accurately calculate the total cost on a per customer basis.
f. The software shall have multiple pre-formatted reports that will, at a minimum, show activity with daily totals, statements, customer and truck usage. The software shall also allow the facility to generate billing statements that can be exported for accounting use. The reports and billing statements shall be easily exported into PDF, CSV, XLS, and other formats.

PART 3 - EXECUTION

3.1 PREPARATION

A. An adequate concrete equipment pad shall be provided (by others) for installation of the septage receiving station and ancillary equipment.

3.2 INSTALLATION

A. The equipment shall be installed as indicated within the Contract Documents and in conformance with manufacturer's instructions.

B. Install the system on a concrete equipment pad poured level as indicated on the Contract Documents.

C. It shall be the Contractor's responsibility to provide any an items not specifically provided by the Manufacturer in order to provide a complete and functional system.

3.3 SPARE PARTS

A. The manufacturer shall provide a list of required spare parts including:

1. Five (5) spare spray nozzles.
2. One (1) solenoid valve rebuild kit.
3. One (1) HDPE drum seal.

3.4 START-UP ASSISTANCE AND TRAINING

A. Startup Services: Engage a factory-authorized service representative to perform start-up services and to train Owner's maintenance personnel as specified below:

1. Once the septage receiving station has been installed correctly and is operating as intended, the service representative shall perform sixteen (16) hours of on-site start-up assistance and operator training.
2. Schedule training with Owner with at least seven days advance notice.

3.5 ADJUSTING AND CLEANING

A. Information on minor periodic adjustments and cleaning is contained in the Operating and Maintenance Manual.

END OF SECTION 44 42 28

SECTION 44 42 56 – SUBMERSIBLE WASTEWATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Submersible Pumps

1.3 GENERAL REQUIREMENTS

A. All castings for pumps and motor frames shall be free of pits, blisters, burrs, or other defects.

B. Pumps shall be furnished with ½" NPT gauge taps on suction and discharge flanges and ¾" NPT drain taps on the volute.

C. Review of the equipment data by the Engineer shall not relieve the Contractor or the manufacturer of responsibility for all detailed dimensions and correct fitting of all parts, or for the satisfactory operation and service of the equipment as specified.

D. When mechanical seals are called for, the Contractor shall furnish the following packaged spare parts for each grouping of identical pumps:

1. Two (2) sets of mechanical seals
2. One (1) shaft sleeve
3. One (1) shaft key

E. Except on close-coupled pumps, pumps shall be connected to motors by flexible couplings of a type suitable for the service conditions.

F. All anti-friction bearings supporting direct-driven shafting shall have a B-10 life rating of not less than 17,000 hours

G. All bearings supporting pinion shafting, worm shafting, or other gear shafting shall have a life of not less than 100,000 hours.

H. All components requiring lubrication, except sealed bearings, shall be provided either with pressure grease connections of Alemite or buttonhead type or with oil cups or oil reservoirs as required.

I. Four (4) pressure grease guns shall be furnished for this project. Guns shall be stainless steel, have 1-quart capacity, and shall be furnished with a flexible extension.

J. Motors:

1. Motors shall be squirrel cage, induction type, of current Characteristics as specified, and shall have horsepower ratings adequate for driving the connected units under all conditions of loading.
2. Motors shall be guaranteed to continuously carry 115% of the rated loads without injurious heating.
3. All motors shall be furnished with not less than Class B insulation unless otherwise noted.
4. All motors shall have cast iron frames, shall be copper-wound, and shall be rated as "premium energy efficient" or "high energy efficient".
5. Motors greater than 40 HP shall be protected with phase protection.
6. Motors to be connected to VFDs shall be manufactured with an inverter grade insulation system capable of withstanding the waveform stresses produced by the VFD.
7. Premium efficiency components shall also be used to offset the increased losses of sinusoidal input with harmonic input.
8. All motors shall have nominal efficiency ratings as follows when tested per requirements of NEMA Mg 1-12.53a, and rating (nameplating) shall be per requirements of NEMA Mg 1-12.53b:

HORSEPOWER	NOMINAL FULL-LOAD EFFICIENCY, %**
¾	81.5
1	84.0
1½	85.5
2	86.5
3	88.5
5	88.5
7½	90.2
10	90.2
15	91.7
20	92.4
25	93.0
30	93.0
40	93.6
50	93.6
60	94.5
75 and greater	96.0

** Efficiencies may vary slightly with RPM selected.

9. The design and manufacture of all motors shall comply with the General Specifications of the A.I.E.E.
10. All motors shall have windings impregnated with moisture-proof compound, and shall be open drip-proof, splash proof, weatherproof, or totally enclosed.

1.4 SUBMITTALS

A. Product Data: Include performance curves, furnished specialties, and accessories for each type and size of pump indicated.

B. Shop Drawings: Show layout and connections for pumps. Include setting drawings with templates, conduit locations, directions for installing foundation and anchor bolts, and other anchorages.

C. Maintenance Data: For each type and size of pump specified to include any maintenance manuals specified in Division 1.

D. The Contractor, equipment manufacturer(s) and/or supplier(s), and representative(s) shall be responsible for reviewing the specified equipment during the bid period, and confirming that the specified equipment and appurtenances are suitable for use in this application, and, for notifying the Engineer immediately upon discovery of any issues with the use of the equipment in this application.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with the pump manufacturer’s rigging instructions for handling.

D. Each pump shall be performance tested at the manufacturer's plant before shipment.

1. Testing will include checking the unit at its rated speed, head, capacity, efficiency, and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve.
2. Certified copies of test curves will be submitted to the Engineer for review and approval before the shipment of any equipment to the job site.
3. The Standard of the Hydraulic Institute shall govern the procedures and calculations for all performance testing.

E. Submersible pumps shall be tested as follows before shipment from the factory:

1. Impeller, motor rating, and electrical connections shall first be checked for compliance with the customer's purchase order.
2. A motor and cable insulation test for moisture content or insulation defects shall be made.
3. Before submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
4. The pump shall be run for 30 minutes submerged, a minimum of six (6) feet underwater.
5. After operational test No. 4, the insulation test (No. 2) is to be performed again.

6. A written report stating the foregoing steps have been done shall be supplied with each pump at the time of shipment upon request. The pump cable end will be sealed with a high-quality protective covering, to make it impervious to moisture or water seepage before electrical installation.

1.6 WARRANTY

A. Warranty Period: 5-year prorated manufacturer's warranty.

1. The warranty shall be for unlimited usage of the equipment for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.1 PUMP MANUFACTURERS

A. Manufacturers

1. Flygt
2. KSB
3. Grundfos

2.2 SUBMERSIBLE PUMPS

A. Provide three (3) submersible pumps designed to pump raw, unscreened wastewater influent. The pumps shall meet the following performance criteria:

INFLUENT PUMPS No. 1, 2, & 3	
Pump Information	Operating Point
Capacity (GPM) – 1 Pump Operating:	4,170
TDH (ft.) – 1 Pump Operating:	60
Capacity (GPM) – 2 Pumps Operating in Parallel:	8335
TDH (ft.) – 2 Pumps Operating in Parallel:	73
Motor (HP):	127
RPM	1778
Voltage(V)/Frequency(Hz)	460/60
Motor shall be inverter duty	

B. Provide two (2) submersible pumps designed to pump return activated (RAS) sludge. The pumps shall replace the existing pumps in the Influent Pump Station and meet the following performance criteria:

RAS PUMPS No. 1 & 2	
Pump Information	Operating Point
Capacity (GPM):	4,200
TDH (ft.):	25
Motor Size (HP):	40
RPM	887
Voltage(V)/Frequency(Hz)	460/60
Motor shall be inverter duty	

C. Provide two (2) submersible pumps designed to pump waste activated (WAS) sludge. The pumps shall located in the new RAS/WAS/Drain Pump Station and meet the following performance criteria:

WAS PUMPS No. 1 & 2	
Pump Information	Operating
Capacity (GPM):	350
TDH (ft.):	6
Motor Size (HP):	3
RPM	1179
Voltage(V)/Frequency(Hz)	460/60
Motor shall be inverter duty	

D. Provide two (2) submersible pumps designed to pump process water drainage from treatment basins. The pumps shall located in the new RAS/WAS/Drain Pump Station and meet the following performance criteria:

DRAIN PUMPS No. 1 & 2	
Pump Information	Operating Point
Capacity (GPM):	350
TDH (ft.):	6
Motor Size (HP):	30
RPM	1173
Voltage(V)/Frequency(Hz)	460/60

E. Provide one (1) submersible pump designed to pump scum and floatables from the final clarifiers. The pumps shall located in the new Scum Pump Station and meet the following performance criteria:

SCUM PUMP No. 1	
Pump Information	Operating Point
Capacity (GPM):	250
TDH (ft.):	14
Motor Size (HP):	2.1
RPM	1740
Voltage(V)/Frequency(Hz)	460/60

F. Pumps shall be designed to operate with variable frequency drives (VFDs). The contractor shall provide VFDs per the Electrical drawings and specifications.

G. Pump shall be constructed of the following materials:

1. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes and other irregularities.
2. Where watertight sealing is required, o-rings made of nitrile rubber shall be used.
3. All exposed nuts and bolts shall be stainless steel 304 construction.

H. Motor:

1. The pumps motors shall be suitable for use with variable frequency drives (VFDs). See electrical plans and specifications for all motor starter requirements.
2. The submersible pump motor shall be a squirrel-cage induction shell type design, housed in an air-filled watertight chamber.
3. The use of oil-filled motors shall not be considered an acceptable equal to the specified air-filled motor.
4. The stator winding and stator leads shall be insulated with moisture resistant Class F insulation which will resist a temperature of 180 degrees C (356 degrees F).

Class A, B, or F insulation shall not be acceptable.

5. The stator shall be insulated by the trickle impregnation method using Class H monomer-free resin resulting in a winding fill factor of at least 95%.
6. The use of pins, bolts, or other fastening devices requiring penetration of the stator housing shall not be considered acceptable.
7. The motor shall be designed for continuous duty and shall be capable of sustaining a minimum of fifteen (15) starts per hour, with written documentation provided to verify this.
8. Rotor bars and short circuit rings shall be made of aluminum.
9. The motor shall not draw more than the specified input KW at nominal voltage at utility supply quality.
10. The junction chamber containing the terminal board shall be sealed from the motor by an elastomer compression seal (o-ring).
11. The connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board and thus perfectly leakproof.
12. Three (3) thermal sensors shall be embedded in the stator winding end coils (one per phase). These sensors shall be wired to the control panel for additional motor overload protection and shall shut down the pumps if a high temperature condition is sensed in the stator. Pump leakage sensing devices shall be provided within each pump as recommended by the pump supplier. A separate pump overtemp/leakage monitoring relay shall be provided by the pump supplier to the associated starter supplier (for mounting within the separate starter by the starter supplier). Each pump monitoring relay shall include separate dry contacts for “leakage” and “overtemp” alarms as indicated on wiring diagrams on contract documents.

I. Pump shaft shall be AISI type 420 stainless steel.

J. Pump finishes:

1. All surfaces in direct contact with sewage, other than stainless steel, shall be protected by an approved sewage resistant coating.
2. Impeller shall be coated with Rilsan.
3. Pump exterior shall be sprayed with PVC epoxy primer, with chloric rubber paint finish.

K. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber o-rings.

L. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machine surfaces.

M. No secondary sealing compounds, rectangular gaskets, elliptical o-rings, grease or other devices shall be used.

N. Pumps shall be equipped with a cable entry water seal design.

1. Cable entry water seal is to be completely replaceable in the field without the need for new pump components or the use of potting compounds.
2. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside

diameter and the entry inside diameter.
3. The gland shall be compressed by the entry body to provide a strain relief function, separate from the function of sealing the cable.
4. The assembly shall bear against a shoulder in the pump top.
5. The junction chamber and terminal board shall be separated from the motor by an o-ring seal, which shall isolate the motor interior from foreign material gaining access through the pump top.

O. Each pump shall be provided with a tandem mechanical rotating shaft seal system.

1. Seals shall run in an oil reservoir, and lapped seal faces must be hydrodynamically lubricated at a constant rate.
2. The lower seal unit between the pump and oil chamber shall contain one stationary and one positively driven tungsten carbide ring.
3. The upper seal unit between the oil sump and motor housing shall contain one stationary tungsten carbide ring and one positively driven rotating carbon ring.
4. Each interface shall be held in contact by its own spring system.
5. The seals shall not require maintenance or adjustment and shall be easily inspected and replaceable.
6. The following seal types shall not be considered acceptable nor equal to the dual independent seal as specified herein:

    a. Shaft seals without positively driven rotating members
    b. Conventional double mechanical seals containing either a common single or double spring acting between the upper and lower units.

P. Each pump shall be provided with an oil chamber for the shaft sealing system.

1. The oil chamber shall not require a pressure equalizer ring for oil pressure compensation.
2. Seal lubrication shall require an oil chamber capacity no greater than 11.5 pints.
3. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside.

Q. The pump shaft shall rotate on two permanently lubricated bearings.

1. The upper bearing shall be a single row roller bearing and the lower bearing shall be a two-row angular contact bearing.
2. A minimum B-10 bearing life of 17,500 hours shall be required when the pump is operating at or near the best efficiency point.

R. The impeller shall consist of the following:

1. The impeller shall be of ASTM A-48, Class 35B grey cast iron, dynamically balanced, semi-open, multi-vane, backswept, screw-shaped, non-clog design.
2. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located in the pump volute.
3. The leading edges of the impeller shall be hardened to Rc 45 and shall be capable of handling solids, fibrous materials, heavy sludge, and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater.
4. The impeller to volute clearance shall be readily adjustable by the means of a

single trim screw.

5. The impeller shall be locked to the shaft, held by an impeller bolt.
6. The volute shall have a replaceable insert ring in which are cast spiral-shaped, sharp-edged grooves. The spiral grooves shall provide trash release pathways and sharp edges across which each impeller vane leading edge shall cross during rotation to remain unobstructed. The insert ring shall be of cast ASTM A-48, Class 35B, and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

S. The volute shall consist of the following:

1. The Volute shall be of single piece design and shall have smooth fluid passages large enough at all points to pass any size solids which can pass through the impeller.
2. A wear ring system shall be installed to provide efficient sealing between the volute and impeller. The wear ring shall consist of a stationary ring made of nitrile rubber molded with a steel ring insert which is drive fitted to the volute inlet.

T. Each pump shall be provided with an adequately designed cooling system consisting of the following:

1. A stainless steel motor cooling jacket shall encircle the motor housing, providing for dissipation of motor heat regardless of the type of pump installation.
2. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed-loop system in turbulent flow providing for superior heat transfer.
3. The cooling system shall have one fill port and one drain port integral to the cooling jacket.
4. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers, or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

2.3 CONTROLS

A. General: Refer to electrical plans and specifications for controls, instrumentation and control panel requirements.

B. Scum Pump Station: Refer to electrical plans and specifications for controls, instrumentation and control panel requirements.

1. One (1) Control Panel shall be furnished by the scum pump shall be provided for control of the scum pump station
2. Refer to Specification Section 26 29 00 “Manufactured Control Panels” for additional requirements
3. The equipment manufacturer shall be responsible for the proper sizing and operation of the control equipment to adequately protect and control the scum pump system equipment.
4. The single control enclosure shall be of:
   a. NEMA 4X stainless steel construction
   b. Sufficient size to contain all controls for the scum pump equipment.
5. Rated for 480V-3phase input
6. Include the starter and all controls for the scum pump,

7. Furnished with NC solenoid valve
8. Furnished with three teflon-coated stainless steel float switch along with all controls
9. SCADA I/O per the SCADA point lists on electrical plans

PART 2 - EXECUTION

2.1 EXAMINATION

A. Examine areas and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting the performance of pumps and equipment.

2.2 INSTALLATION AND OPERATION

A. Comply with the manufacturer's detailed written instructions for installing pump equipment.

B. Installation and operation shall be per instructions and recommendations provided by the manufacturer.

C. Install pumps and arrange to provide access for maintenance, including removal of motors, impellers, couplings, and accessories.

D. Support piping so the weight of piping is not supported by pumps.

E. Check installation, alignment, and provide supervision of initial startup and operation.

F. Verify that all units are in condition suitable for installation; are properly fitted, assembled, and installed; are accurately leveled and aligned, and are ready for satisfactory operation.

G. Set and check pump controls for automatic start, stop, and alarm operation as required for system application.

H. Final Checks before Starting: Perform the following preventive maintenance operations:

1. Lubricate bearings.
2. Disconnect couplings and check motors for proper direction of rotation.
3. Verify that each pump is free to rotate by hand. Do not operate the pump if it is bound or drags until the cause of the trouble is determined and corrected.
4. Verify that pump controls are correct for the required application.

2.3 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition or replace them with new ones.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure equipment is without damage or deterioration at the time of Substantial Completion.

2.4 START-UP ASSISTANCE AND TRAINING

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train the Owner's maintenance personnel as specified below:

1. Factory authorized service representatives of each pump and/or pump manufacturer shall perform all necessary on-site assistance for installation supervision.
2. Once the pumps have been installed correctly and are operating as intended, the service representatives shall perform eight (8) hours of on-site start-up assistance and operator training for each type of pump.
3. Train the Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventive maintenance.
4. Schedule training with the Owner with at least seven days advance notice.

END OF SECTION 44 42 56

SECTION 44 42 63 – SLUDGE DEWATERING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Section 26 29 00 Manufactured Control Panels

C. Section 27 60 05 Field Instrumentation

1.2 SUMMARY

A. The dewatering system has been pre-selected by the Owner through a request for proposals solicited to dewatering system Manufacturers. The specifications that follow were the basis for manufacturers to develop proposals and the pre-selected manufacturer's proposal can be found in **Appendix C** of these specifications.

B. The Work of this section includes a complete solids dewatering system and all associated components. The section shall serve as a detailed description of the scope of supply for the services of dewatering system suppliers.

C. The dewatering system shall be provided complete with all accessories and appurtenances, and be the end product of one responsible system manufacturer or system supplier. The supplier shall furnish and/or coordinate all components and accessories as necessary to place the equipment in operation in conformance with the specified performance, features and functions indicated herein.

D. An installing Contractor shall be responsible for furnishing and installing the system as specified herein.

1.3 SUBMITTALS

A. The Contractor shall provide system submittals as follows:

1. Submit required copies of the Manufacturer's literature, dimensional drawings, wiring diagrams, motor data, performance data, materials of construction, a description of the process design (Operational Description), a description of the control system software logic (Functional Design Specification), Alarm and I/O List, and any other information necessary to determine compliance of the equipment to the specification and project requirements.
2. Highlight project-specific model numbers and options in equipment data sheets.
3. Submittal drawings showing plan, elevation and cross sections of the equipment.
4. Component details of the dewatering equipment.
5. Materials and Manufacturing specifications.
6. Dewatering System submittal information to include:

a. Equipment data sheets.
b. Performance data including pump curves and efficiencies.
c. Headloss calculations and pressure requirements.
d. Customer contact list with telephone numbers (minimum of 5 contacts from similar size facilities).

B. Operation and maintenance manual with installation instructions. Submit after approval of equipment and before shipment.

C. Process Performance Guarantee and Warranty

D. Additional submittal requirements per Specification Section 01 33 00.

1.4 QUALITY ASSURANCE

A. The supplier shall have experience in the design, manufacture, supply, and commissioning of dewatering systems, of the type specified for this project.

B. The manufacturer shall have available skilled supervision and start-up services as specified.

C. The Contractor shall provide the services of the manufacturer service/start-up technician to supervise and inspect and certify the equipment is operating as designed. The Manufacturer will provide classroom and field training on the operation and maintenance required at each installation. The Manufacturer shall provide a factory trained service/start-up technician for two (2) trips including a total of eight (8) workdays to inspect the installation, observe/assist in start-up and supervise the performance testing and Owner's training. The manufacturer's service/start-up technician days on site shall be 8 hours per day not including travel time. The manufacturer's service/start-up technician shall provide additional time on-site at no cost to the Owner if required to resolve start-up issues associated with the system equipment, programming or other issues due to system design or performance. Any additional days on-site, if requested by the owner, shall be negotiated between the Owner and the Manufacturer.

D. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the service engineer present.

E. The service engineer shall make all necessary adjustments and settings to the controls.

F. The service engineer shall demonstrate the proper and sequential operation of the dewatering system. The dewatering system shall be able to operate fully automatically.

G. The Owner will NOT provide written acceptance of the system until training is complete.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be delivered in unopened, undamaged crates designed for handling and storage.

B. Equipment shall be stored and protected per the Manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 SCOPE OF SUPPLY

A. Sludge dewatering press

B. Flocculation tank

C. Sludge feed pumps

D. Sludge cake pump

E. Polymer dilution and dosing equipment

F. In-line grinder

G. Dewatering Drums and spray wash down system

H. Self-contained control panel

I. Technical assistance to the Contractor during Construction.

J. Commissioning, Start-up, Testing, and Training of the Owner's operation staff.

2.2 SYSTEM DESIGN AND PERFORMANCE CRITERIA

A. All parts of the dewatering system shall be designed and appropriate for the service specified and for continuous operation.

B. All parts shall be designed and manufactured to handle the forces that may be exerted on the equipment during fabrication, shipping, erection, and proper operation according to the O&M manual.

C. All components shall be arranged so that they can be serviced from the operating floor.

D. All components shall be balanced so that jamming at any point shall not result in structural failure, but will cause the drive motor to stall. All components including the gear reducer shall be designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor.

2.3 SLUDGE DEWATERING PRESS

A. The Basis of the Design for the solids dewatering system is summarized in Table 1:

Table 1: Basis of Design for Solids Dewatering System	
Design Conditions	
WWTF influent flow, monthly average (MGD)	6
Influent BOD_5, monthly average (mg/L)	300 mg/l
Influent TSS, monthly average (mg/L)	300 mg/l
WAS production (before digestion) (GPD)	129,000 @ 0.8% solids concentration
WAS production after digestion (to dewatering) GPD)	52,000 @ 1.5% solids concentration
Annual solids production	1,234 dry U.S. tons per year
% Solids in feed to dewatering equipment	Range of 1% to 2% solids concentration
Hours of operation per week	CCWSA desires to operate dewatering equipment approximately 60 hours/week (maximum), but will consider other options based on size of equipment and proposals received.
Performance Guarantee and Warranty Requirements	
Solids feed rate to dewatering equipment (GPM)	120
Guaranteed min. % solids for dewatered solids	18.5
Guaranteed min. dry lbs/hour produced	791
Guaranteed % solids captured/processed	95

B. The sludge dewatering press shall be manufactured from 304 stainless steel shapes (rods, angles, fixed rings, moving rings, spacers, end plates, and channels), pipes, and sheets.

1. Support Frame

a. The structural support frame shall be fabricated of type 304 stainless steel members conforming to the latest ASTM Standard Specifications for Structural Steel, Designation A36.
b. The framework shall be of welded and/or bolted construction. All welding shall conform to the American Welding Society Structural Welding Code.
c. The structure shall be designed for installation on a prepared concrete foundation or suitable flat concrete slab and secured with anchor bolts.
d. The construction shall allow easy access and visual inspection of all internal components.
e. The framework shall be of welded and/or bolted construction. All welding shall conform to the American Welding Society Structural Welding Code.
f. The structure shall be designed for installation on a prepared concrete foundation or suitable flat concrete slab and secured with anchor bolts.

g. The construction shall allow easy access and visual inspection of all internal components.

2. Dewatering drums

a. The dewatering drums shall be constructed of ATSM type 304 SS. All circular components shall be laser or water-jet cut to ensure maximum evenness of wear and therefore operating life.

3. Dewatering drum spray system

a. Each Dewatering Drum shall be equipped with individual spray bars. Each spray bar shall consist of a spray pipe fitted with spray nozzles, located above the dewatering drum.
b. Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another on the dewatering drum surface
c. The sprays shall operate periodically and will remove solids built up externally on the drum such that over time no significant buildup of solids occurs on the drum.

4. Dewatering drum drive motor

a. The Dewatering Drum drive motor shall be a one-piece gear motor.
b. Gearmotors shall be hollow shaft, designed to drive the dewatering drum screws with no additional couplings or joints.
c. Motors shall be filled with grease on assembly and sealed for life.
d. Screw rotational speed shall be obtained through a hypoid reduction gear. Input power to the dewatering drum drive shall be supplied through an A.C. variable frequency drive unit.
e. The drive motor shall have the following characteristics:

1)	Motor Horsepower:	5 HP
2)	FLA:	6.5
3)	Power Requirements:	480 VAC, 3 phase, 60 hertz
4)	Enclosure:	TEFC, NEMA B

2.4 FLOCCULATION TANK

A. Mixing and flocculation tanks shall be manufactured as follows:

1.	Capacity	540 gallons
2.	Retention Time	5 mins
3.	Wetted parts	304 S.S.
4.	Legs and cover	304 S.S.

B. Tanks and spill containment trays shall be fully welded internally and externally.

C. Design and manufacture of tanks and spill trays must ensure no leakage or spillage of fluids under normal working conditions. Tank design shall minimize the possibility of

any short circuiting of flow. Tank size shall allow for sufficient residence time for flocculation to occur.

D. The mixer and flocculation tank drive motors shall be a one-piece gear motor. Gearmotors shall be hollow shaft, designed to drive the mixing impeller shafts with no additional couplings or joints.

E. Motors shall be filled with grease on assembly and sealed for life. Mixer rotational speed shall be obtained through a hypoid reduction gear. Input power to the dewatering drum drive shall be supplied through an A.C. variable frequency drive unit allowing variable mixing energy to be input to the system.

1. Flocculation tank drive motor data:
   a. Motor Horsepower: 1.5 HP
   b. Inverter duty type: VFD compatible
   c. Power Requirements: 480 VAC, 3 phase, 60 hertz
   d. Enclosure: TEFC, NEMA B

2.5 POLYMER DOSING SYSTEM

A. The system shall be provided with a polymer preparation system for liquid polymer.

1. Manufacturers

   a. Velodyne

2. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution ranging from 0.1% to 1% concentration of emulsion polymers with active contents up to 75%.
3. The polymer station shall be self-contained with pumps, piping, fittings, accessories and controls. The polymer system shall be factory assembled and tested to eliminate field assembly work and therefore to minimize installation and startup time.
4. The frame shall be 304 stainless steel and the piping shall be Schedule 80 PVC.

B. Polymer Mixing Chamber

1. A hydro-mechanical blending device shall be provided. The device shall be capable of operating on plant water pressure alone at 30 psi. In addition, the system shall be capable of producing its mixing energy independent of plant water pressure through a variable intensity, controllable mechanical mixer. The system shall be capable of producing high, non-damaging mixing energy at all flow rates without damage to the polymer's molecular structure.
2. The mixing chamber shall be clear to view the mixing action and blending effectiveness. Clear pipe shall not be acceptable to meet this requirement. The mixing chamber shall have a maximum rated pressure of 100 psi. All holes tapped in plastic shall have helicoil inserts for increased strength.
3. To handle the wide range of polymers available, independent of water pressure, a variable-speed stainless steel mechanical mixing impeller shall be provided.

a. The mixer shall be designed specifically to effectively induce high, non-damaging mixing energy over the system's full flow range. The specially designed impeller shall be controlled by an SCR controller. The impeller shall be driven by a wash-down duty motor.
b. Mixer motor

1)	Horsepower	½ HP
2)	Voltage	90 VDC
3)	Speed	1750 RPM

c. The mixer drive shaft shall be sealed by a mechanical seal which shall have an integrally mounted and factory plumbed seal flushing valve. A drain port behind the seal shall be provided in the mixing chamber to drain the polymer solution in case of a seal failure. The seal shall be easily accessible for replacement. Systems without a seal flushing system shall not be considered.
d. Systems that rely solely on water pressure to create mixing energy shall not be acceptable. Systems that rely solely on water pressure to create mixing energy will be considered only if provided with an integrally mounted dilution water booster pump and if the system meets the above polymer mixing criteria.

4. A VFD motor controller shall be provided to control the pressure and therefore mixing energy generated by the booster pump. Booster pumps shall be multi-staged and of stainless steel construction.
5. The booster pump shall be capable of generating 75 psi independent of water supply pressure which shall be verified at system start-up. In the event the booster pump cannot produce 75 psi of water pressure a properly sized booster pump shall be installed at the supplier’s expense.
6. Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water.

a. The valve shall be designed with an open, unobstructed path to the valve seat. The valve body shall be constructed of Teflon with Viton seals.
b. The valve poppet and spring shall be stainless steel and designed to prevent polymer from flowing through the spring, causing build-up and plugging. Plastic spring covers shall not be used.
c. The valve shall be readily accessible for cleaning and shall not require tools for removal, cleaning or replacement.
d. Conventional check valves, valves that rely on ball seals, and or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted.
e. The locking pin used to hold the valve in place shall be attached to the mixing chamber with a lanyard.

C. Neat Polymer Metering Pump Assembly

1. Two(2) neat polymer metering pumps shall be provided, one duty and one standby. The pump assembly shall have the following components:

a. FNPT Union Style Polymer Inlet
b. Neat Polymer Metering Pump Type: 2 (two) Seepex Progressive Cavity with Gear Reducer, Series MD 0015-24
c. Pump Motor: 2 (two) 1/2 HP, 90 VDC, 1750 RPM, TENV, F1
d. Neat Polymer Loss of Flow Sensor: Thermal Flow Sensor, 120 VAC
e. Metering Pump Calibration Assembly with Isolation Valves (sized for 1-minute draw-down)
f. Plumbing: SCH. 80 PVC

D. Dilution Water Inlet Assembly

1. The dilution water assembly shall have the following components:

a. Stainless Steel FNPT Water Inlet Connection
b. Dilution Water ON/OFF Valve: ASCO Solenoid Valve, 120 VAC, Brass/NBR
c. Dilution Water Flow Control Valve: Manual Rate Flow Control Valve
d. Primary Dilution Water Flow Meter Type: Rotameter
e. Low Differential Pressure Alarm Switch Across the Neat Polymer Activation Chamber
f. Pressure Gauge (Stainless Steel, Liquid Filled), 2.5" Dial, 0-160 PSI
g. Plumbing: SCH. 80 PVC

E. Solution Discharge Assembly

1. The dilution discharge assembly shall have the following components:

a. Stainless Steel FNPT Solution Discharge Connection
b. Pressure Gauge (Stainless Steel, Liquid Filled), 2.5" Dial, 0-160 PSI
c. Plumbing: SCH. 80 PVC

F. Polymer Dosing System Control Panel

1. Enclosure: NEMA 4X (FRP)
2. Power Option: 120V / 1PH / 60Hz
3. Power Disconnect Type: 10 ft. power cord with 120 VAC plug
4. PLC Controller: None (Discrete Control Panel)
5. HMI Operator Interface: None (Discrete Control Panel)
6. Motor Controllers:

a. Neat Polymer Metering Pump
b. Mixing Chamber

7. Miscellaneous

a. Control Circuit Protection
b. Control Relays
c. Power Supplies
d. Grounding Blocks
e. Numbers Terminal Blocks
f. Wire Labels, Shrink-tube type

8. Control Level:

    a. Series D (Discrete Controller)

        1) Operator Interface - Discrete Selector Switch:
            a) System On / Off / Remote
            b) Polymer Pump 1 / Pump 2 Selector Switch
            c) Ten-Turn Potentiometer - Metering Pump 1 Control
            d) Ten-Turn Potentiometer - Metering Pump 2 Control
            e) One-Turn Potentiometer - Mixer Speed Control

    b. Status/Alarm Indicators

        1) System Running Indication
        2) Main Power On Indication
        3) LED Display Metering Pump 1 Rate
        4) LED Display Metering Pump 2 Rate
        5) Low Water Differential Pressure Alarm
        6) Low Polymer Flow Alarm

    c. Inputs (Signals by Others)

        1) Remote Start / Stop (Discrete Dry Contact)
        2) Pacing Signal Based On Process Flow (4-20 mA)

    d. Outputs

        1) System Running (Discrete Dry Contact)
        2) System Remote Mode (Discrete Dry Contact)
        3) Low Water Differential Pressure Alarm (Discrete Dry Contact)

G. Polymer Dosing System Skid

1. Frame – 304 stainless steel
2. Hardware – 18-8 stainless steel

H. System Skid

1. The system skid shall be constructed of 304 stainless steel and shall be of adequate size to space components for proper maintenance and replacement.
2. Hardware shall be 18-8 stainless steel

2.6 PROGRESSIVE CAVITY PUMPS – SLUDGE FEED AND CAKE PUMPS

A. The progressive cavity pumps shall be provided by the Dewatering System Supplier and installed by the Contractor.

B. All castings for pumps and motor frames shall be free of pits, blisters, burrs, or other defects.

C. Pumps shall be furnished with ½" NPT gauge taps on suction and discharge flanges and ¾" NPT drain taps on the volute.

D. Review of the equipment data by the Engineer shall not relieve the Contractor or the manufacturer of responsibility for all detailed dimensions and correct fitting of all parts, or for the satisfactory operation and service of the equipment as specified.

E. When mechanical seals are called for, the Contractor shall furnish the following packaged spare parts for each grouping of identical pumps:

1. Two (2) sets of mechanical seals
2. One (1) shaft sleeve
3. One (1) shaft key

F. Except on close-coupled pumps, pumps shall be connected to motors by flexible couplings of a type suitable for the service conditions.

G. All anti-friction bearings supporting direct-driven shafting shall have a B-10 life rating of not less than 17,000 hours.

H. All bearings supporting pinion shafting, worm shafting, or other gear shafting shall have life of not less than 100,000 hours.

I. All components requiring lubrication, except sealed bearings, shall be provided either with pressure grease connections of Alemite or buttonhead type or with oil cups or oil reservoirs as required.

J. Motors:

1. Motors shall be squirrel cage, induction type, of current Characteristics as specified, and shall have horsepower ratings adequate for driving the connected units under all conditions of loading.
2. Motors shall be guaranteed to continuously carry 115% of the rated loads without injurious heating.
3. All motors shall be furnished with not less than Class B insulation unless otherwise noted.
4. All motors shall have cast iron frames, shall be copper-wound, and shall be rated as "premium energy efficient" or "high energy efficient".
5. Motors greater than 40 HP shall be protected with phase protection.
6. Motors to be connected to VFDs shall be manufactured with an inverter-grade insulation system capable of withstanding the waveform stresses produced by the VFD.
7. Premium efficiency components shall also be used to offset the increased losses of sinusoidal input with harmonic input.
8. All motors shall have nominal efficiency ratings as follows when tested per requirements of NEMA Mg 1-12.53a, and rating (nameplating) shall be per requirements of NEMA Mg 1-12.53b.
9. The design and manufacture of all motors shall comply with the General Specifications of the A.I.E.E.

10. All motors shall have windings impregnated with moisture-proof compound, and shall be open drip-proof, splashproof, weatherproof, or totally enclosed.

K. Delivery, Storage, and Handling

1. Retain shipping flange protective covers and protective coatings during storage.
2. Protect bearings and couplings against damage.
3. Comply with the pump manufacturer’s rigging instructions for handling.
4. Each pump shall be performance tested at the manufacturer's plant before shipment.

    a. Testing will include checking the unit at its rated speed, head, capacity, efficiency, and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve.
    b. Certified copies of test curves will be submitted to the Engineer for review and approval before the shipment of any equipment to the job site.
    c. The Standard of the Hydraulic Institute shall govern the procedures and calculations for all performance testing.

L. Pump Manufacturers

1. Seepex

M. Sludge Feed Pumps

1. Performance and Design Requirements

    a. The pumping units shall be of the self-priming, positive displacement, progressing cavity-type specifically designed for pumping the specified wastewater sludge.
    b. Sludge handling pumps shall be specifically designed and selected for continuous duty pumping of liquids with the following properties:

        1) Percent Solids: Up to 8%
        2) pH: 6.0-6.5

    c. The pumps shall be of the compact, close-coupled design. The gear reducer shall be sized for a minimum service factor of 1.5 and designed with a thrust load capability of 150 percent of the actual thrust load.
    d. The pumps, along with associated drive appurtenances, shall be mounted on commonly fabricated steel baseplates.
    e. Manufacturers must currently have installations for the same liquids and of the same size pump unit, in service for a minimum of three years. Manufacturers not named in this specification must also provide a pre-submittal package to the engineer no less than three weeks before the bid date for approval. The pre-submittal package must include, at minimum, the following: dimensional drawing, performance curve, O&M manual, electrical/drive details, installation list (for the same liquids as specified) with a minimum of three contacts and phone numbers.

2. The Sludge Feed Pumps shall have the following operating characteristics:

Table 2: Sludge Feed Pumps (Solids Handling Facility)	
Pump Information	Pump Nos. 1 & 2
Capacity (GPM):	200
TDH (psi.):	30
Motor Size (HP):	15
Run dry protection	Included

a. Materials: The sludge pump components shall be constructed of the following:

1) Rotor: C45, Hardened Tool Steel, chromium nitride coated
2) Stator: Buna N
3) Pump Body: Cast iron
4) Shaft Sealing: Burgmann MG1 Q1Q1VGG

1) Accessories/Run Dry Protection: The stator shall be fitted with a sensor sleeve and thermistor sensor. A compatible controller shall also be provided by the pump supplier and shall be installed by the contractor in a j-box adjacent to the motor as shown on plans, and interconnected to the starter for pump shutdown controls. The controller shall monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller. The controller shall include a manual local and remote reset function. Input to the controller shall be 1x115VAC/60 Hz.

c. Over Pressure Protection:

1) Each progressive cavity pump shall be supplied with a silicone-filled isolation ring with a dual-mounted gauge and single pressure switch.
2) The pressure ranges for the switch and gauge shall be selected specifically for each specified service.
3) The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans, and be constructed with a carbon steel body and fittings with a Buna sleeve.
4) The switch shall be SPDT, NEMA 4 and shall be monitored and alarmed if the preselected pressure is exceeded

d. Standby Components

1) One set of special tools shall be provided to service the pumps.

e. Operating Conditions for Sludge Feed Pumps

1) The pump shall be of the self-priming, positive displacement, progressing cavity-type specifically designed for pumping the specified wastewater sludge.
2) Sludge handling pumps shall be specifically designed and selected for continuous duty pumping of liquids with the following properties:
3) Percent Solids: Up to 28%
4) pH: 5.0 - 6.5
5) The pump shall be of the compact, close-coupled design. The gear reducer shall be sized for a minimum service factor of 1.5 and designed with a thrust load capability of 150 percent of the actual thrust load.
6) The pump, along with associated drive appurtenances, shall be mounted on commonly fabricated steel baseplates.

f. Manufacturers must currently have installations for the same liquids and of the same size pump unit, in service for a minimum of three years. Manufacturers not named in this specification must also provide a pre-submittal package to the engineer no less than three weeks before the bid date for approval. The pre-submittal package must include, at minimum, the following: dimensional drawing, performance curve, O&M manual, electrical/drive details, installation list (for the same liquids as specified) with a minimum of three contacts and phone numbers.

3. The Sludge Cake pump shall have the following operating characteristics:

Table 3: Sludge Cake Pump (Solids Handling Facility)

Pump Information	Pump No. 1
Capacity (GPM):	TBD
Pressure Rating (PSI)	TBD
Motor Size (HP):	TBD
Run Dry Protection	Included

a. Accessories/Run Dry Protection: The stator shall be fitted with a sensor sleeve and thermistor sensor. A compatible controller shall also be provided by the pump supplier and shall be installed by the contractor in a j-box adjacent to the motor as shown on plans, and interconnected to the starter for pump shutdown controls. The controller shall monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller. The controller shall include a manual local and remote reset function. Input to the controller shall be 1x115VAC/60 Hz.

a. Over Pressure Protection:

1) The pump unit shall be supplied with a silicone-filled isolation ring with a dual-mounted gauge and single-point pressure switch.
2) The pressure ranges for the switch and gauge shall be selected specifically for each specified service.
3) The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans, and be constructed with a carbon steel body and fittings with a Buna sleeve.
4) The switch shall be SPDT, NEMA 4.
5) Overpressure alarm monitoring

b. Hopper Extension with Laser Mounting Brackets: The pump shall be supplied with a hopper extension that is pre-installed and flange mounted to the pump. The hopper extension shall include the following as a minimum:

1) A maximum overall height of no more than 5-1/4"
2) Shall include an open hopper flange for the integration of the pump with a customer-supplied transition hopper that will extend from the dewatering equipment to the extension flange.
3) The integral flanged hopper extension shall integrate a window on the drive end of the hopper extension. This window will be used for level measurement and presence/absence detection of cake.
4) The integral hopper extension shall include a metal fabricated sloped canopy internal to the hopper extension and covering the window. This canopy will eliminate any cake from falling out of the hopper and obstructing the level measurement and presence/absence detectors.
5) The hopper extension shall incorporate a flexible polycarbonate shield that will divert falling cake away from the level measurement equipment signal. This shield will be clear polycarbonate and will be between 1/8" and ¼" thick depending on the application. It will be flexible to prevent cake build-up and eliminate the possibility of bridging.
6) The hopper extension shall include all adjustable brackets to mount all of the presence/absence and level control transmitters and receivers.

c. Laser Level Transmitter: The pump will be supplied/installed with three (3) pre-programmed laser measurement devices that incorporate the following characteristics:

1) Each laser shall be self-contained and have an IP67 rating for being capable of being fully submerged.
2) Must be able to measure distances ranging from 8"-390" with an overall accuracy of not more ¾" where extraneous light is less than 40klx.
3) The laser level transmitter shall project a dot no larger than 5/8" diameter at the maximum measuring length.
4) The laser measurement system shall be able to operate in environmental temperatures ranging from 15-140° F

5) Each laser transmitter shall utilize sealed M12 connections to prevent any contamination, but easy period maintenance or removal and replacement.
6) Each laser transmitter shall incorporate a discrete output to represent the laser line being broken by falling cake. Additionally, the laser transmitter shall include an analog process signal indicating the proximity of cake from the sensor.
7) Each of the three laser transmitters shall be programmed identically to permit them to measure level or indicate the presence of cake. The operator shall be able to switch the function of each transmitter only by swapping the M12 quick connector.

d. Level Controller: The system shall include a level controller to analyze all of the level signals and provide on-the-fly filtering to determine the proper operation and speed of the pump to keep the process operating continuously. The controller shall be manufactured by the pump manufacturer and include the following features:

1) Minimum of 5 previous installations that incorporate the controller and hardened control algorithms.
2) The controller shall be housed in a non-metallic enclosure that carries a minimum rating of NEMA 4X.
3) The controller shall feature a 5.7" color touch screen, capable of producing a 64,000 color gamut, which will permit operators of selecting or changing parameters of operation. The display shall incorporate a resistive touch display that will permit operation with gloved hands.
4) The control system shall permit the control of boundary layer injection pumps to reduce frictional piping losses pressure in the application that may convey for longer distances.
5) The controller shall be capable of accepting/transmitting a minimum of the following control signals:
6) Qty four (4) analog process inputs.
7) Qty four (4) analog process outputs.
8) Qty sixteen (16) discrete inputs that are 24 VDC tolerant
9) Qty fifteen (15) dry contact relay outputs that are each rated for 10 Amps resistive.
10) The level controller shall be the Seepex Touch controller manufactured by Seepex, Inc.

e. Injection ring: A multiport injection ring shall be provided and installed adjacent to the pump discharge. The wetting ring shall provide water from the plant water source to lubricate the discharge piping upon pump start.

2. Standby Components: The following components shall be furnished:

1) One set of special tools shall be provided to service the pumps.
2) One (1) stator assembly with TSE sensor sleeve
3) One (1) rotor
4) One (1) set universal joint assemblies

5) One (2) set packing

2.7 IN-LINE GRINDER

A. This section of the specification describes the grinders, power packs, and controllers. The equipment shall be installed as shown on the plans, as recommended by the supplier, and in compliance with all OSHA, local, state and federal codes and regulations.

B. The in-line grinder shall be provided by the Dewatering System Supplier and installed by the Contractor.

C. Grinders shall be Muffin Monster Model 30004T by JWC Environmental

D. General

1. Grinder shall be two-shafted design consisting of individual cutters and spacers. The cutters shall actively grab and pull material into the stack for shredding. Grinder shall have a single piece main body housing with integral pipe flanges and inspection ports. Cutter cartridge shall be removable with the main body housing remaining in situ. Cutter cartridge shall have an upper and lower end housings to retain shaft support bearings and seals. Grinder shall have motor and speed reducer for cutter drive. The equipment shall operate at low speed with a maximum cutter shaft speed of 60 rpm.

E. Design Summary

1. Number of grinders:	1
2. Number of motor controllers:	1
3. Environment rating for grinders:	Non-hazardous
4. Environment rating for motor controllers:	Non-hazardous
5. Supply power characteristics:	460 volt / 3 phase / 60 Hertz

F. Equipment

1. Cutter type:	11-tooth
2. Spacer type:	Smooth
3. Shaft seal type:	Mechanical, Tungsten Carbide
4. Seal maximum pressure:	90 psi (620 kPa)
5. Speed reducer type and ratio:	Cycloidal, 29:1
6. Installed horsepower:	3 hp (2.2 kW)
7. Motor type:	TEFC
8. Motor service factor:	1.15
9. Minimum motor efficiency (at full load):	84.0%
10. Minimum motor power factor (at full load):	82.0%
11. Minimum peak shaft torque:	4,756 lb-in/hp (721 Nm/kW)
12. Minimum peak force at cutter tip:	2,020 lb_f/hp (12,047 N/kW)

G. Components

1. Cutters and Spacers

    a. Cutting stack shall be of nominal height listed in Performance Requirements.
    b. Cutters shall have 11 teeth and be 0.310” (7.87 mm) nominal thickness.
    c. Spacers shall be 0.319” (8.1 mm) nominal thickness.
    d. Cutters and spacers shall be individual disks constructed of heat treated alloy steel.
    e. Cutter tooth height shall be not greater than ½-inch (13 mm) above the root diameter of the cutter.
    f. Cutter outside diameter shall not exceed a maximum 4.71" (120 mm).
    g. Cutter thickness tolerance shall be +.000/-.001” (+.000/-.025 mm). Spacer thickness tolerance shall be +.001/-.000” (+.025/-.000 mm).
    h. Cutters shall be heat treated to 45-53 HRc.
    i. Spacers shall be heat treated to 34-53 HRc.
    j. Spacers shall have a smooth outside diameter.
    k. Cutter to cutter clearance shall be a maximum of 0.011” (0.28 mm).

2. Shafts

    a. Shafts shall be hexagonal, 2” (50.8 mm) across flats.
    b. Shafts shall be of heat treated 4140 alloy steel with a minimum tensile strength of 149,000 psi (1,027 kPa).
    c. Shaft hardness shall be 38-48 Rockwell C.

3. Intermediate Shaft Yokes (as applicable)

    a. Intermediate shaft yokes shall provide radial support to the shafts during severe grinding demands.
    b. Intermediate shaft yokes shall be constructed of 304 stainless steel, 660 bronze, and 17-4PH Stainless steel.
    c. Intermediate shaft yokes shall be factory lubricated with high temperature marine grade grease.
    d. Grease fittings shall be provided on intermediate shaft yokes for periodic maintenance.
    e. Intermediate shaft yokes shall only be supplied on 24-inch (610 mm) cutter stacks.

4. Shaft Bearings and Seals

    a. Radial and axial loads shall be borne by sealed, oversized, deep-groove ball bearings.
    b. Shaft seal type shall be mechanical.
    c. Each bearing and seal arrangement shall be incorporated into a cartridge-style housing.
    d. Cutter shafts shall be supported on both ends. Cantilever-style arrangements shall not be permitted.

e. Dynamic and rotating seal faces shall be Tungsten Carbide with 6% Nickel binder.
f. Seal cartridges shall be rated to a maximum pressure of 90 psi (620 kPa).
g. O-rings shall be of BUNA-N.
h. Seal cartridges shall not require flushing.
i. Seals shall be rated to operate wet or dry.

5. Housings and Covers

a. Housings and covers shall be of ASTM A536 ductile iron.
b. Main body housing shall have integral inlet and outlet flanges.
c. Flange bolt pattern shall be as listed in Performance Requirements.
d. Main body housing shall have integral side wall deflectors to direct solids into cutters.
e. Inspection port covers shall be on both inlet and outlet sides of main body housing.
f. End housings shall have integral bushing deflectors to guide solids away from seal cartridges.
g. Housings shall not contain grit or debris traps requiring periodic cleaning.

6. Transfer Gears

a. Transfer gears shall be of involute profile and fabricated from heat treated alloy steel.
b. Transfer gear tooth design, thickness and hardness shall be suitable to transfer torque between shafts up to the rated breakdown torque of the motor.
c. The interface between transfer gears shall be factory lubricated with grease to minimize wear.
d. The transfer gear ratio shall be such that the ratio of cutter tip speed of the low speed shaft to cutter tip speed of the high speed shaft shall be greater than 0.90 and less than 1.00 to promote tearing of material as it passes through the cutter stack and at the same time facilitate cleanout of material from between the cutters.

7. Low Speed Coupling

a. Low speed coupling shall be a 3-jaw type.
b. The 3-jaw halves shall be of hardened 4140 alloy steel.
c. Each low speed coupling half shall be encapsulated on its mating shaft to facilitate proper engagement of coupling lobes (1/16” – 1/8”).
d. The interface between low speed coupling halves shall be factory lubricated with grease to minimize wear.

8. Speed Reducer

a. Speed reducer shall be manufactured by Sumitomo Machinery Corporation of America.
b. Speed reducer shall be a cycloidal type.
c. Gear motor speed reduction ratio shall be 29:1.

d. Speed reducer shall be grease lubricated.

9. High Speed Coupling

    a. High speed coupling shall be a 3-jaw type with elastomer spider.
    b. The 3-jaw halves shall be of sintered iron.
    c. The spider shall be of BUNA-N.

10. Lifting Brackets: Grinder shall be fitted with two (2) fabricated lifting rings.

H. Grinder Controller

1. The grinder motor starter(s) and controls shall be incorporated into the dewatering system suppliers control panel.
2. Control panel shall have I/O points as called for on the SCADA point lists.
3. Control panel shall provide programmable operation of the grinder system.
4. Control panel shall have switches, indicator lights, and other control devices.
5. Control panel shall be designed to suit the supply power and motor characteristics listed in Performance Requirements.
6. Refer to Specification Section 26 29 00 (“Manufactured Control Panels”) for additional control panel requirements.

I. Operation

1. Grinder control shall be per the setting of the On-Off/Reset-Remote selector switch.

    a. In the OFF/RESET position the grinder shall not run. Motor controller faults shall be cleared.
    b. In the ON position, the grinder shall run forward.
    c. In the REMOTE position, the grinder shall operate as controlled by a remote start/stop dry contact.

2. When an obstruction jams the grinder, the controller shall stop the grinder and reverse the rotation to clear the obstruction. If the obstruction is cleared, the controller shall return the grinder to normal operation. If three (3) reverses occur within a 30 second interval, the controller shall stop the grinder motor and activate the grinder FAIL indicator and relay.
3. When a motor overload or motor over-temperature condition occurs, the motor shall be de-energized, the MOTOR FAULT indicator lamp shall be illuminated and the FAIL contact shall be closed.
4. When a power failure occurs while the system is operating, the system shall return to normal operation when power is restored.
5. When a power failure occurs while the grinder is in a fail condition, the system shall return to a fail state when power is restored. The fail state shall not be cleared until reset.
6. Reset of the grinder shall be accomplished from the controller only.

J. Paint Coatings (Ferrous Materials): Ferrous metal surfaces shall be prepared to SSPC-SP6 (Commercial Blast Cleaning) and coated with minimum 6-8 mils TDFT (total dry film thickness) paint of type and color listed in Performance Requirements.

K. Paint Coatings (Previously-Coated Components)

1. Previously-coated components (motors, speed reducers, etc.) shall be prepared to SSPC-SP1 (Solvent Cleaning) and SSPC-SP2 (Hand Tool Cleaning) and coated with minimum 6-8 mils TDFT (total dry film thickness) paint of type and color listed in Performance Requirements.

2.8 SYSTEM CONTROLS AND INSTRUMENTATION

A. Provide one systemcontrol panel constructed of 304 stainless steel, NEMA 4X construction.

B. The panel shall be a full operating panel complete with all motor control and supervisory devices for press-mounted and ancillary equipment. All electrical work shall be performed per applicable local and national electric codes. The control panel shall include a Modicon PLC-based electronic control panel which will automatically control all of the functions and operations of the Sludge Dewatering system and a 12” color OIT Modicon touch screen. Allen Bradley AC Power Flex 40 Variable Frequency Drives or equal by Square D shall be used for individual components in the local control panel(s).

C. The ancillary equipment to be controlled by this panel includes the sludge feed pumps, sludge grinders, polymer feed units, flocculation/mix tank, tank mixers, level sensors, polymer solution pumps, washwater booster pump, discharge cake pump.

D. All equipment starters and VFDs will be located in the dewatering system control panel. The polymer solution pumps shall have VFDs. The washwater booster pump and discharge cake pump will have motor starters in the dewatering system control panel. All motor starters and VFDs will be protected by in-line dedicated circuit breakers. The PLC will include logic for all necessary system interlocks and will control process and emergency shutdowns.

E. The controls shall be such that selection of the desired ancillary equipment is easily accomplished at the OIT touchscreen for the dewatering equipment.

F. Three phase, 480 volt, 60-Hertz power shall be supplied to the control panels. A control transformer will be provided for 120-volt, single phase power source for motor starter coils, lights, relays, timers, controllers, and other related items.

G. Each control panel shall be provided with terminal blocks for power wiring to and from the panel. The incoming terminal blocks shall be provided with a single magnetic circuit breaker disconnect switch. Circuit breaker protected motor starters with thermal overloads shall be supplied for each motor furnished with the unit.

H. All electrical equipment controls located on each screw press shall have Nema 4X enclosures and wired, through PVC conduit, to a single common Nema 4X terminal box.

I. All devices within the panel shall be permanently identified. Nameplates shall be provided on the face of the panel or on the individual device as required. Nameplates shall be made of laminated phenolic materials with a white face and a black core.

J. The panel shall be designed for manual starting and stopping of all drives. A master manual / auto system switch shall be supplied to override the alarm system and allow operation of any drive through a momentary contact pushbutton. The control panel shall contain start/stop pushbuttons, run lights, and alarm indications for the sludge pumps, polymer systems, cake pump, and the booster pumps.

K. The operator interface terminal (OIT) touchscreen shall be equipped with a start/stop switch and run light for each adjustable piece of equipment. The control panel OIT shall be equipped with speed control and status for all equipment with VFDs.

L. The control panel shall include start/ stop pushbutton, run lights, speed control and 4 to 20 mA signal generators for the polymer feed systems.

M. The control panel shall also include provisions to communicate over the plant SCADA system (using copper Ethernet from the Sludge Dewatering control panel to SCADA) to monitor status and alarms of all equipment.

N. The SCADA PLC shall interface with the Sludge Dewatering System PLC for monitoring and alarms. Control of the system shall be at the supplier's control panel.

1. It shall be the responsibility of the sludge dewatering system supplier to provide all of the necessary control hardware, software and components as required for a complete installation.
2. The PLC shall be furnished with a Modbus TCP copper Ethernet output port (for communication to the plant SCADA system).

O. Alarm lights, sensors, and related circuitry shall be provided for the following functions: zero speed, emergency stop push button on each side of the press, low water pressure, and low air pressure. In the event of any of the above malfunctions, the machine will shut down and an alarm sound. The alarm system shall include an audible horn rated at 90 DBA at 10'. The system shall include silencing provisions, but the function alarm indicating light shall remain lit until the alarm condition is satisfied. A separate set of alarm contacts shall be provided for remote alarm indication.

P. Arrange control panel to allow either manual or automatic control of sludge dewatering system equipment. When “MANUAL” operation is selected, all equipment associated with the screw press shall be controlled by “START/STOP” pushbuttons on the touchscreen. When “AUTOMATIC” operation is selected, control of equipment shall be “AUTOMATIC/START” and “AUTOMATIC/STOP” pushbuttons on the touchscreen, and programmable controller.

Q. The system control panels shall include OIT touchscreens with the control mode selector switch marked “AUTOMATIC/MANUAL.” When “MANUAL” operation is selected, all equipment associated with screw press shall be controlled by “START/STOP” pushbuttons.

1. One speed potentiometer for manual adjustment of each drive speed.
2. Digital indicators for sludge feed flow rate. Indicators shall accept 4 to 20 mADC field input and shall be calibrated in gpm.
3. Green indicating lights for “RUNNING” status for each unit operated from panel, including wash water solenoid valve energized indication.
4. Red indicating lights for “OFF” status for each unit operated from panel, including wash water solenoid valve de energized indication.
5. One each “AUTOMATIC/START” and one “AUTOMATIC/STOP” momentary pushbuttons, for automatically starting and stopping the sludge dewatering system. Sludge cake pump shall be manually controlled when screw press control mode selector switch is in either the “AUTOMATIC” or “MANUAL” position.
6. One “EMERGENCY STOP” red mushroom pushbutton.

R. Automatic Controls and Sequencing:

1. General:

a. Program the PLC for automatic control of screw press, system sequencing, and interlock functions as specified.
b. Configuration and programming of PLC system shall be responsibility of screw press Manufacturer. System documentation including memory loading, I/O configuration and programming shall be provided.
c. Provide and install auxiliary relays and wiring for equipment and devices specified in this Section required for implementing functional requirements specified.

S. “AUTOMATIC Start/Automatic Stop” Cycle (typical for all screw presses):

1. Automatic start cycle request to PLC shall be initiated by “AUTOMATIC/START” pushbutton.
2. Control logic for an “AUTOMATIC/START” cycle shall sludge dewatering system in the following order after “AUTOMATIC/START” command has been initiated and interlocks are complete.

a. Wash water pump.
b. Screw Shower “Pre-Wash”
c. Discharge cake pump.
d. Screw press drive.
e. Rotary drum drive.
f. Polymer systems drive.
g. Grinder
h. Sludge feed pumps.

3. Each drive shall not start until previous drive is running and necessary time delay has elapsed. The screw press Manufacturer shall determine where time delays

are required and shall program settings and sequence to provide a smooth start-up of equipment.

4. Once all drives are confirmed running by motor run contacts from their respective starters, PLC shall cause the run indicating light to illuminate. Loss of run status contact for a drive once cycle logic is complete shall shut down screw press and associated equipment.
5. Upon “AutoMATIC /STOP” command, system shall shut down in order that is reverse of specified start-up order with necessary time delays.
6. Interlocks: The interlocks shall be satisfied when control mode selector switch is in either “Automatic” or “Manual” position. Failure of any one signal during start cycle or after cycle is complete shall shut down all associated screw press equipment.
7. Annunciation and Alarms: Provide audible alarm and detailed alarm history in screw press control panel for alarming for all equipment controlled by the screw press control panel
8. Additional stations shall be included as hereinafter specified for other ancillary drives or systems.
9. Electric Motors furnished with this equipment shall meet the following requirements:

    a. Rated for continuous duty at 40°C ambient and insulated with a minimum of Class F insulation, with Class B temperature rise. All motors shall be totally enclosed, fan cooled or non-ventilated. All motors supplied shall be rated at 150% nameplate horsepower of the required horsepower maximum service condition.

10. Refer to Specification Section 26 29 00 for additional control panel requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting the performance of pumps and equipment.

3.2 INSTALLATION AND OPERATION

A. Comply with manufacturer's detailed written instructions for installing pump equipment.

B. Installation and operation shall be per instructions and recommendations provided by the manufacturer.

C. Install pumps and arrange to provide access for maintenance, including removal of motors, impellers, couplings, and accessories.

D. Support piping so the weight of piping is not supported by pumps.

E. Check installation, alignment, and provide supervision of initial startup and operation.

F. Verify that all units are in condition suitable for installation; are properly fitted, assembled, and installed; are accurately leveled and aligned, and are ready for satisfactory operation.

G. Set and check pump controls for automatic start, stop, and alarm operation as required for system application.

H. Final Checks before Starting: Perform the following preventive maintenance operations:

1. Lubricate bearings.
2. Disconnect couplings and check motors for proper direction of rotation.
3. Verify that each pump is free to rotate by hand. Do not operate the pump if it is bound or drags until the cause of the trouble is determined and corrected.
4. Verify that pump controls are correct for the required application.

3.3 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition or replace them with new ones.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure equipment is without damage or deterioration at the time of Substantial Completion.

3.4 START-UP ASSISTANCE AND TRAINING

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train the Owner's maintenance personnel as specified below:

1. Factory authorized service representatives of each pump and/or pump manufacturer shall perform all necessary on-site assistance for installation supervision.
2. Once the pumps have been installed correctly and are operating as intended, the service representatives shall perform eight (8) hours of on-site start-up assistance and operator training for each type of pump.
3. Train the Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventive maintenance.
4. Schedule training with the Owner with at least seven days advance notice.

3.5 OWNER ACCEPTANCE

A. In addition to the documentation associated with the completion of the Acceptance Testing, the Manufacturer shall provide the Owner with documentation that states the installation of the dewatering system has been inspected, meets the manufacturer’s guaranteed requirements, and is free from faults and defects. Once this documentation is received and training is complete, the Owner will issue a written letter of acceptance.

3.6 PERFORMANCE GUARANTEE AND WARRANTY

A. The Dewatering System Manufacturer (supplier) shall provide a performance guarantee that states the following:

1. The dewatering system Manufacturer hereby unconditionally and irrevocably guarantees to the Owner, the performance and operating parameters described in these specifications and as submitted in the Manufacturers's proposal.
2. The dewatering system Manufacturer agrees the system performance shall be based on field measurements from instrumentation as monitored by the Owner. The Owner agrees to immediately notify the dewatering system Manufacturer if the guaranteed performance and operating parameters are not met.
3. If the system fails to perform at the guaranteed levels of performance and operation, the supplier agrees to pay the Owner 100 percent of the operating costs differential for the period beginning after written notification of non-compliance is received by the supplier and continuing until the system is again operating within these specifications.
4. The supplier agrees to pay to the Owner all reasonable costs and expenses, for engineering, legal or otherwise, which may be incurred in the successful enforcement of any liability of the supplier under this performance guarantee.
5. The Manufacturer shall furnish a three (3) year performance bond covering satisfactory performance of the dewatering system equipment; FOB to Shenandoah WWTF and shall include parts only (not labor). The performance bond shall be in an amount to cover complete replacement of all system equipment, all of which will comply with the performance requirements required and guaranteed by the Manufacturer. Obliges of the Bond shall be the Owner and the Contractor. Bonds shall be furnished with the Manufacturer as principal and with corporate surety satisfactory to the owner and authorized to do business in the State of Georgia and countersigned by an agent whose office is located in the State of Georgia.

B. Manufacturers shall provide a 1-year warranty for all system components from the date of successful startup and Owner acceptance unless otherwise noted.

C. Equipment with five (5) year warranty.

1. Screw Press
2. Sludge feed pumps
3. Sludge cake pump
4. In-line grinder
5. Flocculation tanks and mixers
6. Polymer Dosing System

1.2 SPARE PARTS

A. Recommended spare parts shall be furnished by the manufacturer.

END OF SECTION 44 42 63

SECTION 44 42 68 – FLOATING DECANTER

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. This section covers the technical specifications for floating decanter equipment and appurtenances for a complete working system.
B. Under this section of the specification, the contractor shall provide and install the equipment in the digesters as shown in the contract drawings and as described herein.

1.3 SUBMITTALS

A. The contractor shall provide product data, drawings and calculations as follows:

1. Decanter design, layout, material, and support structure
2. Engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
4. All ancillary equipment to be provided by the manufacturer shall be listed.
5. Operation & Maintenance Manuals

1.4 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be delivered, stored and protected in accordance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/FABRICATORS

A. Subject to compliance with requirements, provide products by one of the following:

1. Parkson
2. Or equivalent fabricator experienced with the design of floating decanters.

2.2 FLOATING DECANTER

A. Decanter shall function by floating up and down with changing water levels allowing effluent to escape while excluding suspended solids from entering the decanter.
B. Decanter design shall utilize multiple orifices to keep effluent velocities to a minimum. Orifices shall be located such that effluent is pulled from below the water surface when the effluent valve is opened to eliminate the possibility of entraining scum, floating debris, sludge, and foam.

C. To allow the decanter to be raised above the water level, supply stainless steel cable attached to the decanter in no less than three locations. Connect cables with loop sleeves, thimbles, and at least one turnbuckle. A single cable shall extend to hoist assembly. Hoist assembly shall consist of a winch, manufactured by Thern or equivalent, mount base anchored to concrete slab (or top of wall), and mounting post to allow for operation of winch above the handrail elevation.

2.3 PRODUCTS

A. Decant Pipe
1. The decant pipe shall be 6” diameter, schedule 10, T-304 stainless steel pipe or 6” diameter, schedule 40 PVC pipe, with dimensions as shown on the drawings.

B. Swivel Joint or Reinforced Flexible Coupling
1. Decant pipe shall be connected to wall pipe by reinforced flexible coupling or stainless steel swivel joint equipped with BUNA seals for submerged operation.

C. Float
1. Shall consist of a PVC or FRP pontoons/housing with closed cell foam filling to prevent submersion even in the event of a small leak in the exterior housing. To include T-304 stainless steel frame assembly.

D. Support stop
1. T-304 stainless steel floor mounted support stand for resting decanter at stop point.
2. Decanter shall rest on a support assembly when digester level is below the decanter outlet.
3. Entire system shall be coordinated with aeration equipment layout

E. Hardware
1. All field assembly bolts and anchor bolts, nuts, and washers shall be Type 316 stainless steel.
2. All submerged connections shall utilize Type 316 stainless steel nylon insert locknuts.

2.4 FABRICATION

A. All welded joints that will be fully or partially submerged shall be sealed watertight with continuous welds. All welding shall be performed in accordance with AWS standards.

B. All parts and components shall be factory-assembled in sections convenient for field handling and installation but requiring the minimum amount of work for field assembly. Any field assembly work shall be bolted. No cutting or welding should be required on either field assembly or erection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of piping systems to verify actual locations of piping connections

before installation.

B. Examine decanter for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Coordinate installation with aeration equipment.

D. Examine interior of decanter for cleanliness, freedom from foreign matter, and corrosion

3.1 INSTALLATION

A. Equipment should be stored in accordance with the manufacturer's recommendations.

END OF SECTION 44 42 68

SECTION 44 42 70 - INDIRECT BIOSOLIDS DRYING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Section 26 29 00 Manufactured Control Panels

1.2 DEFINITIONS

A. Contractor - The person, partnership, corporation, association, or affiliation with whom the OWNER executes a separate agreement for the installation of the drying system supplied by the SUPPLIER.

B. Engineer - The private engineering firm contracted by the Owner to design and manage the installation of the System and carry out the intent of the project. The Engineer shall act as the Owner's representative to the extent that such authority has been granted to them by their contract with the Owner. The Owner's decision on any matter shall be final and supersedes any decision made by the Engineer.

C. Owner - The entity contracting the work being completed.

D. Supplier - The person, partnership, corporation, association, or affiliation with whom the Owner executes an agreement for supplying the System equipment under this contract.

E. System - The complete drying system, which shall include all equipment, controls, instrumentation, and other appurtenances as described herein.

1.3 SUMMARY

A. The indirect biosolids drying system has been pre-selected by the Owner through a request for proposals solicited to indirect biosolids drying system Manufacturers. The specifications that follow were the basis for manufacturers to develop proposals and the pre-selected manufacturer’s proposal can be found in **Appendix D** of these specifications.

B. The Work of this section includes a complete indirect biosolids drying system and all associated components. The section shall serve as a detailed description of the scope of supply for the services of indirect biosolids drying system suppliers.

C. The indirect biosolids drying system shall be provided complete with all accessories and appurtenances, and be the end product of one responsible system manufacturer or system supplier. The supplier shall furnish and/or coordinate all components and

accessories as necessary to place the equipment in operation in conformance with the specified performance, features and functions indicated herein.

D. An installing Contractor shall be responsible for furnishing and installing the system as specified herein.

1.4 WORK OF THIS SECTION

A. This Section covers the work necessary to provide an indirect type biosolids drying system, complete and including the equipment and components listed as ancillary equipment, electrical and control systems, as specified herein. Also included in this Section is the detailed design, installation assistance, Operations and Maintenance Manuals, training, and testing and startup services.

B. The Supplier shall design, fabricate, and supply all the equipment necessary to provide a complete Biosolids Drying System, including all ancillary equipment as defined herein. The Biosolids Drying System shall be capable of producing a dried product from a dewatered sludge cake at the rates specified herein and meet the specified performance requirements. The supplier will arrange shipment of the materials to site, and provide site supervision for installation, commissioning, optimization, and customer training.

C. Supplier to provide all drawings and documentation as in attached Schedule of Document Required List (SDRL), as necessary for the design completion by the Engineer of the associated site, building and process improvements.

D. This Section describes the process and major mechanical components comprising the Biosolids Drying System (“System’) and establishes the minimum quality standards for equipment, materials of construction, and process performance.

E. The System shall include a complete Instrumentation and Control System (“I&CS”) to provide automated and manual operations for the System. The I&CS shall be designed for unattended fully automatic operation, in conformance with the Supplier's Safety Management Plan. The I&CS shall include all materials and documentation required to install, test, and place into operation the System. It shall include all measuring elements, control devices, signal converters, transmitters, local control panels, motor control centers, digital hardware and software, Human Machine Interface, and communication networks to provide the required functionality. The Owner or Contractor will need to supply internet connectivity for full functionality of optional remote support by Supplier.

F. The heating source for the System shall be natural gas with a design heating value of 1,000 Btu/Std. cubic foot.

G. Items to be included in the System shall include, but not be limited to, the following:

1. Sludge Cake Hopper with Live bottoms, leveling screws, Load cells and level transmitter.
2. Feed Pump with temperature sensor and pressure sensor.
3. A fired thermal-fluid heating system using natural gas and utilizing thermal fluid for the indirect heating application. The thermal fluid heating system shall be suitable for the design function and shall include a complete control package, recirculating pump, burner, expansion tank and ancillary systems.

4. Indirect, thermal-fluid heated, screw dryer, to evaporate water and to produce dried biosolids.
5. Discharge conveyor for transferring the dry product from the dryer to the cooling conveyor.
6. Cooling Conveyor for reducing final product temperature prior to delivery to Owner's storage or load-out system.
7. A pelletizing system to shape the dried biosolids into a pellet ¼" in diameter by approximately 1" in length. The Pelletizing system shall be suitable for the design function and shall include a hopper, pellet mill, pellet cooler, and ancillary systems.
8. Conveyance and loadout systems for moving the dried biosolids from the cooling conveyor discharge to either the pelletizer package or bypassing the pelletizer package for load out into engineer specified bulk container. Pellets will also have a separate load out conveyor into separate engineer specified bulk container.
9. Consolidated dust management consisting of wet dust collector with integrated collection fan. Rated for 4,000 CFM.
10. Multi-stage condenser for temperature reduction and removal of moisture and particulates from the dryer exhaust-gas system.
11. Odor-control system for removal of odorous emissions from the non-condensable exhaust gas system.
12. Fan(s), to remove air or other non-condensable gases through the System and to control pressure. Including oxygen sensor for monitoring & alarm.
13. Safety features or systems as applicable to the System, to meet the requirements of the Supplier's Safety Management Plan. These may include pressure-relief devices, air-lock devices, inert-gas purge and oxidant-reduction systems, fire protection and prevention systems as required. Features and systems shall generate and maintain an inert or reduced oxidant atmosphere in the dryer for the prevention of deflagrations as permitted by NFPA 69.
14. A complete I&CS package for complete automatic, unattended operation, and remote monitoring (internet connection by Owner/Contractor).
15. Electrical system components to include electrical-power distribution, motors, motor starters, motor-control components, variable-frequency drives, junction boxes, skid-mounted raceways or conduits and skid mounted wiring as required for functionality.
16. Equipment and controls not appearing in the list above, but necessary for the complete system are not eliminated by reason of such omission and shall be provided by the Supplier unless specifically noted as being supplied by others.
17. All equipment, instrumentation, electrical components, and wiring methods shall be rated for the hazardous environment, if any, in which they are located as shown on the Owner's site plan drawing or as described in the Supplier's Safety Management Plan and as required by codes and standards including, but not limited to, NFPA 70 and NFPA 499.

1.5 GENERAL

A. Unit Responsibility: A single Supplier shall be responsible for supplying the Biosolids Drying System, complete with all accessories and appurtenances. The Supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and, as necessary to place the equipment in operation, in conformance with the specified performance, features and functions.

B. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts and manufacturers' services.

C. AC Induction Motor Requirements: All drive motors on the Dryer System shall be inverter duty ready and shall meet the requirements of NEMA MG 1-2011, Part 31. Provide voltage spike resistant insulation. Capable of constant torque duty over a 10:1 speed range.

D. Control System Requirements: Conform to the requirements of Package Control Systems.

1. The control functions contained and described herein are intended to provide proposed minimum performance requirements. They do not necessarily identify each control function, connection, communications or equipment to achieve the requirements. Additional specificity and details shall be coordinated at time of submittals.

1.6 REFERENCES

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

1. American National Standards Institute (ANSI).
2. American Welding Society (AWS).
3. American Society of Mechanical Engineers (ASME): PTC-36, Measurement of Industrial Sound.
4. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, 2010 Edition.
5. ASTM International (ASTM): G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests.
6. Occupational Safety and Health Act (OSHA).
7. National Fire Protection Association (NFPA).
8. National Electric Code (NEC).
9. Instrument Society of American (ISA).
10. Institute of Electrical and Electronics Engineers (IEEE).
11. American Gear Manufacturers Association (AGMA).
12. Anti-Friction Bearing Manufacturers Association (AFBMA).

1.7 SUBMITTALS

A. The Contractor shall provide system submittals as follows:

1. Submit required copies of the Manufacturer’s literature, dimensional drawings, wiring diagrams, motor data, performance data, materials of construction, a description of the process design (Operational Description), a description of the control system software logic (Functional Design Specification), Alarm and I/O List, and any other information necessary to determine compliance of the equipment to the specification and project requirements.
2. Highlight project-specific model numbers and options in equipment data sheets.
3. Submittal drawings showing plan, elevation and cross sections of the equipment.
4. Component details of the indirect biosolids drying equipment.
5. Materials and Manufacturing specifications.
6. Indirect biosolids drying system submittal information to include items B-D below:

B. Action Submittals:

1. System Description

   a. Process Flow Diagram (PFD) and Heat and Material Balance for the System.
   b. Process and Instrumentation Diagram (P&ID) for the System indicating:

      i. Standard PIP & ISA symbols, numbering and terminology.
      ii. Equipment and motors.
      iii. Piping, ductwork, valves and other process line appurtenances.
      iv. Instrumentation and control panels.
      v. Power connections with voltage(s).
      vi. Process control communication and analog- and discrete inputs/outputs (I/O).

   c. Process description narrative including equipment operation and logic,
   d. Utility Datasheet indicating electrical, natural gas, plant water, potable water and drain requirements including voltage, current, flow, temperature and pressure as appropriate.
   e. Safety Management Plan for design, construction, testing, commissioning, personnel training, operations and maintenance. The Safety Management Plan shall include a section on emergency response procedures. The provisions of the Safety Management Plan shall be consistent with the requirement for unattended, fully automatic operation and shall include procedures for safe startup, operation, operating adjustments and all shutdown scenarios (standard planned shutdown and emergency shutdown).
   f. Tie-point Schedule indicating size and type of process and electrical connections.

2. Shop Drawings

   a. General Arrangement drawing(s) of individual equipment including:

      i. Plan and elevation views
      ii. Dimensions
      iii. Weights and loading
      iv. Process connections
      v. Access or minimum clearances for service, repair or removal
      vi. Bill of Materials listing major components

   b. Location plan drawing(s) indicating anchor-bolt locations with general recommended anchor-bolt grades and sizes.

      i. Seismic, structural and foundation calculations and design shall be provided by others.

3. Equipment Description

   a. Equipment Schedule
   b. Motor Schedule, indicating inverter requirements where applicable.
   c. Equipment Datasheets for major equipment including:

      i. Manufacturer and model
      ii. Description data, performance characteristics and efficiencies

iii. Design, code and testing requirements
iv. Materials of construction
v. Motor type, horsepower, speed, phase, voltage and service factor
vi. Speed reducer type, size, ratio and service factor
vii. Bearing type and life
viii. Seal type

4. Instrument and Controls Description

a. Instrument Schedule including motor controllers (variable frequency drives, VFD).
b. Electrical schematics including:

i. Power distribution also indicating location of VFDs.
ii. Programmable Logic Controller (PLC) components, inputs, and outputs.
iii. Control panel interconnections indicating terminal blocks and numbering, wiring types and labels.
iv. Control panel drawings including:

(i) Interior and exterior plan and elevation views
(ii) Placement of operator interface devices

c. Control description including:

i. Function description of process variables or final control elements to be monitored, controlled, alarmed and/or recorded.
ii. Process & Control narrative including logic, permissive and interlocks.
iii. Alarm and fault schedule or Cause & Effect matrix indicating instrument interfaces and automatic shutdown features.

C. Informational Submittals

1. Electronic copy of System PLC program in Rockwell software Studio 5000 format (at delivery of equipment for shipment).
2. Electronic copy of Human Machine Interface (HMI) application in Rockwell software Factory Talk View ME or Ignition Edge SCADA format (at delivery of equipment for shipment).
3. Equipment Description

a. Paint Schedule and paint specifications
b. Manufacturer’s catalog information, specifications, and materials of construction.

4. Operation and Maintenance Manual

a. Recommended spare parts with description for all equipment furnished under this section.
b. Set of complete, as-reviewed, equipment general arrangement submittals.
c. Set of complete, as-built, electrical schematics and equipment drawings.
d. Equipment Schedule, as built.
e. Detailed operating procedures for startup, normal operation, normal shutdown and emergency shutdown consistent with the Supplier’s Safety and Management Plan.
f. Schedule of routine and preventive maintenance requirements.

g. Schedule of troubleshooting procedures.

D. Quality Assurance and Testing

1. Equipment Testing Procedure(s)

a. The Supplier shall submit test procedures for the following tests for review at least 30 days in advance of the notice to conduct the performance testing:

i. System Factory Acceptance Test.
ii. Control System Factory Acceptance Test.
iii. Component Factory Acceptance Test.
iv. Site Acceptance Test (Mechanical and Electrical).
v. Performance (Field) Test.

2. Factory Quality Control

a. Factory test results, reports, and certifications including:

i. System inspection and functional test reports and certificates as per ITP document.
ii. Control panel inspection and functional test reports and certificates.
iii. Shipping, storage and protection, and handling instructions.

3. Field Quality Control

a. The Supplier shall submit test reports within 30 days after completing field testing.
b. Field test results, reports, and certifications including:

i. Supplier's Certificate of Proper Installation.
ii. Performance Test Report.

E. Operation and maintenance manual with installation instructions. Submit after approval of equipment and before shipment
.

F. Process Performance Guarantee and Warranty

G. Additional submittal requirements per Specification Section 01 33 00.

1.8 SYSTEM INTERFACES

A. Dewatered sludge cake shall be delivered to the System from dewatering device(s) via conveyor (or pump) provided by Owner. There will also be sludge cake from other facilities dumped via truck into the hopper (12 yd3 dump capacity).

B. Cooling water with condensate from the Condenser shall flow by gravity to a plant drain provided by the Contractor from a nozzle on the Separator. Piping shall be provided and installed by the Contractor.

C. Non-condensable foul air from the Condenser shall flow to the Odor-Control System from the discharge nozzle on the Foul-Air Fan. Piping/ducting shall be provided and installed by the Contractor.

D. Unless otherwise noted above or shown on the Drawings, no component of the System shall be supported from the building roof or walls. The loads from the System shall be transferred to the foundation or floor slab only.

E. Some equipment components require assembly onsite. The Supplier shall provide, as a minimum, installation and assembly procedures with remote assistance to Contractor during onsite assembly of these components. Supplier will provide onsite supervisory assistance as well.

F. The Contractor shall design piping systems between equipment components that are an integral part of the System. The Contractor shall be responsible for the supply and installation of the interconnecting piping and ducting.

   1. The piping and ducting systems covered under this item include:

      a. Sludge cake. Feed Hopper/Pump to the dryer inlet nozzle
      b. Foul air. Condenser outlet to odor control unit and Feed Hopper vent to the odor control unit.
      c. Thermal fluid. Supply & return piping from the heater skid to the thermal fluid manifold at the dryer.
      d. Transition and connecting duct of the loadout to the pelletizer & the bypass to engineer specified bulk container.
      e. Dust Control. Ducting from the pelletizer system and conveyance system under negative pressure to the supplied wet dust collector.

   2. Supply and return thermal fluid piping, including support shall be issued as general design guidance by the Supplier. Detailed design, fabrication and installation, including Piping supports and insulation shall be provided and installed by the Contractor.

G. The Contractor shall design and provide utility and process piping systems from the Owner’s battery-limit interface point designated on the Drawings, to the tie-point designated in the Supplier's general arrangement drawings listed herein.

   1. The piping systems covered under this item include:

      a. Dewatered sludge cake to the Feed Hopper(s).
      b. Natural gas to the Thermal-Fluid Heater.
      c. Flue gas from the Thermal-Fluid Heater.
      d. Cooling water to the Condenser, cooling screw & the wet dust collector.
      e. Condensate drains from the Condenser.
      f. Drain from the wet dust collector.
      g. Nitrogen supply at various locations to the Dryer.

H. The Supplier shall design and furnish to Owner all components necessary for installation of the electrical systems that are an integral part of the System including motors, motor starters and associated controls, variable frequency drives (VFD), control panels, instrumentation and all other electrical components as described in this Section.

I. The Contractor shall design and provide electrical power connections from the Suppliers Power Distribution Panels and Motor-Control Center (MCC) battery-limit interface point

designated on the Drawings, to the tie-point at control panels designated in the Supplier's general arrangement and electrical schematic drawings listed herein.

1. The electrical power connections covered under this item include:

    a. Dryer Control Panel
    b. Dryer Motor Panel
    c. Dryer UPS Panel
    d. Pelletizer Local Control Panel
    e. Pelletizer Remote I/O (RIO) panel
    f. Pelletizer Main Control Panel
    g. Thermal-Fluid Heater Local Panel.

J. The Supplier’s Control System shall interface with the Owner’s Plant Control System via Ethernet cabling or Fiber as described herein and as shown on the Drawings.

1.9 WORK BY OTHERS

A. The following shall be provided by the Owner, the Engineer, the Contractor or any of their respective subcontractors:

1. Overall plant design.
2. Review of Equipment Drawings and Specifications.
3. Civil works, provision of foundations and buildings, including but not limited to:

    a. Site development, roads, ramps and paving.
    b. Building(s) for housing the drying system.
    c. Floors or equipment foundations.
    d. Drainage, trenches, drains and sewers.
    e. Ventilation and climate-control systems.
    f. Utility systems and lighting.

4. Receiving and safe storage of equipment at site until ready for installation.
5. Installation of equipment including moving, lifting, setting, alignment, anchoring and grouting including:

    a. Provision of anchor bolts.
    b. Assembly of interconnecting equipment, piping or other mechanical appurtenances.

6. Piping and supports described as a System Interface herein.
7. Raw materials, chemicals and utilities during equipment startup and operation.
8. Laboratory services, operating and maintenance personnel during equipment checkout, startup and operations.
9. Any onsite insulation and painting or touchup painting of piping and equipment.

B. Electrical

1. Electrical conduit, raceway and wiring/cabling to provide System power to the required locations.
2. Electrical and instrumentation interconnection including wiring/cabling, conduit, raceway and other appurtenances required to provide power and control connections

as needed, between the Suppliers Control Panel(s) and the Supplier's equipment, as shown on the Supplier's Drawings and/or Tie-Point Schedule.

3. The Plant Control System that interfaces with the Dryer Control Panel.

    a. Ethernet or fiber connection from the Dryer Control Panel to the Plant Control System.

4. IT or networking, such that the Supplier's Control System can interface with the internet to provision for remote troubleshooting including IP addressing.

1.10 SAFETY REQUIREMENTS

A. All equipment furnished shall be designed and manufactured with due regard to safety of operation, accessibility, durability, maintainability, or replacement of parts and shall comply with all applicable provisions of the Occupational Health and Safety Act and other federal, state, and local safety regulations. The System safety provisions shall comply with the Supplier's Safety Management Plan.

1.11 PATENTS

A. The Supplier shall warrant that the use of this system and its equipment, in the process for which the system has been expressly designed and sold by the Supplier, will not infringe on any domestic or international patents. The Supplier shall hereby grant the Owner in perpetuity a license to use any inventions covered by patent or patents owned, pending or controlled by the Supplier in the operation of the facility being constructed hereunder, without the right to grant sublicenses.

1.12 QUALITY ASSURANCE

A. The supplier shall have experience in the design, manufacture, supply, and commissioning of indirect biosolids drying systems, of the type specified for this project.

B. The manufacturer shall have available skilled supervision and start-up services as specified.

C. The Contractor shall provide the services of the manufacturer service/start-up technician to supervise and inspect and certify the equipment is operating as designed. The Manufacturer will provide classroom and field training on the operation and maintenance required at each installation. The Manufacturer shall provide one factory trained service/start-up technician for Installation Supervision Services for two (2) trips including a total of three (3) workdays, one factory trained service/start-up technician for Checking Equipment After Contractor Installation for one (1) trip including a total of two (2) workdays, one factory trained service/start-up technician and one engineer for Startup and Commissioning Services for two (2) trips including a total of ten (10) workdays, one factory trained service/start-up technician for Post Startup – Dryer Optimization and Performance Testing Services for one (1) trip including a total of three (3) workdays, one factory trained service/start-up technician for Final Inspection Services for one (1) trip including a total of one (1) workday, and one factory trained service/start-up technician for Post Start-up Services and Process Training for one (1) trip including a total of four (4) workdays. The manufacturer's service/start-up

technician days on site shall be 8 hours per day not including travel time. The manufacturer's service/start-up technician shall provide additional time on-site at no cost to the Owner if required to resolve start-up issues associated with the system equipment, programming or other issues due to system design or performance. Any additional days on-site, if requested by the owner, shall be negotiated between the Owner and the Manufacturer.

D. Equipment shall not be energized, or “bumped” to check the electrical connection for motor rotation without the service engineer present.

E. The service engineer shall make all necessary adjustments and settings to the controls.

F. The service engineer shall demonstrate the proper and sequential operation of the indirect biosolids drying system. The indirect biosolids drying system shall be able to operate fully automatically.

G. The Owner will NOT provide written acceptance of the system until training is complete.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be delivered in unopened, undamaged crates designed for handling and storage.

B. Equipment shall be stored and protected per the Manufacturer’s recommendations.

PART 2 - PRODUCTS

2.1 GENERAL

A. The System shall consist of the scope of supply of various parts, components, and services as described herein under Part 1 - General. The System shall be capable of continuous operation with a minimum of maintenance.

B. The System shall be suitable for installation in the Owner’s Building.

C. This Section generally describes materials of construction to be used for primary equipment, however, due to variability in the equipment provided by Suppliers, equipment material selection shall be based on a design life of 20 years, considering the anticipated corrosion and abrasion potential of typical municipal sludge in this application.

2.2 SUPPLIER

A. Modifications to Standard Equipment Model Offerings:

1. Listing of a Supplier within this Section shall not be justification for acceptance of the manufacturer's standard model offering.
2. Equipment provided by a listed Supplier shall be furnished and designed or modified as necessary to conform to the performance, functions, features and materials of construction as specified herein.

B. The Biosolids Drying System shall be from the following pre-qualified manufacturers:

1. BCR Bio-Scru.

C. The design equipment layout for the Dryer System in the Owner's Building is based on equipment provided by the BCR Bio-Scru listed above.

2.3 SERVICE CONDITIONS

A. Design Criteria: The Project Design Criteria is summarized in Table 1 (following). The Design Criteria reflects the target dewatering cake solids content of 20 %TS so as optimize feedstock conveyance, bin storage and pumping, and moisture evaporation of the dryers' system.

Table 1: Project Design Criteria Design Criteria

WWTF influent flow, monthly average	1.5 MGD	6.0 MGD	9.0 MGD
Dry Solids Feed Rate -#/Day	1,408	6,760	10,140
Wet Cake Feed Rate - #/Day	7,040	33,800	50,700
Number of Days Operation Per Week	5	5	3.5
Number of hours of Operation Per day	6.0	14.0	24.0
The Total Solids in the Wet Cake (% TS)	20%	20%	20%
% Total Solids in Dried Product	90%	90%	90%
Wet Cake Feed Rate, Total (/Unit) - (Lbs/Hr)	3,285	4,302	4,381
Solids Feed Rate, Total (/Unit) - (Lbs/Hr)	657	860	876
Required Evaporation Rate, Total (/Unit) (Lbs/Hr)	2,555	3,346	3,408
Dried Product Discharge Rate (/Unit) (Lbs/Hr)	730	956	974

B. The material to be dried will be polymer-conditioned, aerobically digested and screw press dewatered sludge. The sludge will originate from secondary biological treatment of municipal wastewater, without separate primary clarification treatment. The characteristics of the sludge may fall anywhere within the ranges listed below:

Table 2: Project Sludge Characteristics

PARAMETER	CONDITION	METHOD OF ANALYSIS
Nominal Sludge Type	100% Aerobically Digested	N/A
Sludge Feed Concentration (% Dry Solids)	18% to 20%	SM 2540G
Sludge Volatile Solids Concentration (% Dry Basis)	60% -75%	SM 2540G
Total fiber content (%-DS)	< 20	NEUTRAL – ANKOM METHOD OR EQUIVALENT
FOG. -Hexane Extractable Material (mg/Kg-DS)	<30,000	EPA 9107B
Total Petroleum Hydrocarbons (mg/Kg-DS)	< 500	EPA 418.1
Sludge Cake Temperature (°F)	70-105	N/A

Maximum Cooling Water Temperature (°F)	72	N/A

C. The Biosolids Drying System shall be designed to evaporate moisture at the stated rate and process the solids for a dewatered sludge cake feed as specified in the table of conditions above.

D. The thermal fluid temperature fed to the Dryer shall not exceed 550°F.Typically the thermal fluid heater would be 425 to 495°F.

E. The dewatered sludge cake to be dried will be fed to the System from the Owner's conveyor/pump into Feed Hopper(s).

F. Sludge shall be dewatered using the Owner's new dewatering screw press.

2.4 PERFORMANCE REQUIREMENTS

A. The Dryer System shall continuously receive and dry the feed sludge specified above, and continuously discharge the dried solids into a load out conveyor located in the Owner's Building. The Dryer System shall be able to operate:

1. Continuously on demand and shall be suitable for drying the specified sludge continuously for up to 24 hours per day, 7 days per week
2. Batch operation of 7 to 12 hours of feed to the dryer (not including the dryer startup & shutdown time) shall be suitable for drying the specified weekly sludge quantity and
3. Without spillage of wet or dry sludge within the Supplier's scope of equipment supply.

B. The System shall dry the feed solids to meet EPA 40 CFR Part 503 Class A pathogen and vector-attraction reduction criteria. Suitable process control systems or features shall be incorporated to ensure these criteria are met on a continuous basis.

C. Supplier shall guarantee that the System shall be capable of the performance requirements specified below, to be confirmed via the field performance testing specified herein while operating with the design basis sludge stream described under the project design criteria and the project sludge characteristics:

PARAMETER	SYSTEM DESIGN BASIS
Guaranteed Minimum Dried-Solids Concentration (% Dry Solids)	90%
Runtime (excluding start-up/shutdown) required at current (1.5 MGD) solids capacity	3.0[1]
Max. natural gas usage at current (1.5 MGD) solids production – Ft^3/Hr	4,020[2]
Max. power usage at current (1.5 MGD) solids production – kW/Hr	140[3]
Runtime (excluding start-up/shutdown) required at current (6.0 MGD) solids capacity	11.0 [1]
Max. natural gas usage at current (6.0 MGD) solids production – Ft^3/Hr	5,220[2]
Max. power usage at current (6.0 MGD) solids production – kW/Hr	140[3]
Noise levels from dryer system (decibels) in the dryer building	< 75 dB[4]

Required time for start-up - Minutes	30 - 45
Required time for shutdown - Minutes	90-180
Maximum Cooling Water Temperature (°F)	72
Comply with 40CFR Part 503 Requirements	Class A PFRP

Notes:

1. Number of hours/day of dryer feed - based (5) days week operation.
2. Natural gas flow is calculated based on 1000 BTU/Ft^3 heat value and the thermal heater skid efficiency of 87% (LHV). Also includes 4% heat loss in the dryer and thermal fluid piping.
3. Consumed electrical power by equipment mentioned included by dryer Supplier in this specification.
4. Noise level in the dryer building will be less than 75dB. The thermal fluid heater skid - including Recirculation pump & the combustion fan are placed in an enclosed area with sound barriers. The Pellet Mill equipment, including the wet dust collector are placed in an enclosed area with sound barriers. This is not including any building ventilation or items other than provided by BCR.

D. Evaporation Rate:

$$\dot{M}_{Evaporation} = \dot{M}_{Feed\ Dry\ Solids} \times (1/X_{Feed\ Dry\ Solids} - 1/X_{Product\ Dry\ Solids})$$

where:

$\dot{M}$ = mass flow rate, lbs/hr
X = mass fraction dry solids, lbs/total lbs

E. The system shall be capable of turndown to a processing (evaporation) rate of 50% of the design rate and operate continuously at that rate in a stable fashion.

2.5 SLUDGE DRYING FUNCTIONAL REQUIREMENTS

A. The System to be supplied under this Section shall meet all the specified duty and capacity requirements and shall be designed to meet all requirements and conditions set out herein.

B. The System shall be designed for unattended, fully automatic operation consistent with the Supplier's Safety Management Plan, with start and stop being initiated locally at the Dryer Control Panel Human Machine Interface, or remotely through the Owner's Plant Control System. The System shall be suitable for either batch or continuous operation up to 24 hours per day, 1 to 7 days per week.

C. The System shall operate automatically with full process-, safety- and control interlocking for instances of:

1. Normal sequential startup of equipment.
2. Sequential startup of equipment following an abnormal shutdown, loss of power or emergency shutdown, activated by interlock or operator initiation.

3. Normal sequential shutdown on operator request or selected process events or conditions (such as empty Feed Hopper(s) or full product storage), reverting to a safe process condition.
4. Emergency sequential shutdown from critical fault alarm or operator request.
5. Where permissible, pause on occasions of select equipment faults to allow operators to remedy fault condition.
6. Pause up to 30 minutes, without feed and without discharging material, to allow operators to switch remove or replace storage containers (trailers, bins, Super-Saks, etc.)

2.6 EQUIPMENT DESCRIPTION

A. Dryer Feed System:

1. General:

a. The dryer feed system shall consist of the following equipment:

i. Feed Hopper(s), quantity one (1).
ii. Feed Hopper Live-Bottom Screws, quantity three (3) per Hopper.
iii. Feed Hopper Leveling Screws, quantity two (2) per Hopper.
iv. Feed Pump, quantity one (1).
v. Load cells and controller.

b. The sludge conveyance system shall provide positive conveyance of dewatered sludge from the Hopper(s) to the Dryer.

2. Feed Hopper(s):

a. The Feed Hopper(s) shall receive dewatered sludge cake from the screw press located adjacent to the hopper, on a higher elevation. Alternately or in conjunction with local dewatered cake, brought in cake in the form of a dump truck (12 yd3 planned dump capacity) may dump into the Feed Hopper.
b. Each Feed Hopper shall have a total capacity is 40.0 cubic yards. Working capacity of Feed Hopper with Biosolids is dependent upon the displayed angle of repose, and the final layout of the screw press inlet, vs the dump inlet (by Engineer).

i. The maximum sidewall height of the Hopper(s) shall not exceed twelve (12) feet Overall All Height (OAL) above the finished floor to allow feed from the dewatering conveyance, and to allow dumping. The final dimensions shall be determined following submission of Shop Drawings.
ii. The shell of the Hopper(s) shall be a minimum or ¼" thick SS 304 steel.

c. The Hopper(s) top, open with grizzly bars, SS 304 steel, removable section for access. The cover of each Hopper shall include the following connections:

i. One *12"* flanged opening shall be included for hopper feed from the onsite dewatered cake (by others).
ii. One 3-inch diameter flanged connection shall be provided for a level transmitter.
iii. The final location of all connections shall be determined following submission of Shop Drawings.

d. The Hopper(s) shall include (3) shaft-less, ribbon-type, live bottom screws to direct dewatered sludge cake into the suction of the Feed Pump.

    i. Each screw shall be separately driven with a geared reducer/motor unit. Each motor shall be inverter grade and controlled by a variable-frequency driver (VFD).

e. Level in the Hopper(s) shall be measured with weigh cells or an alternative reliable level measurement sensor as per Supplier Design.
f. Paint and Coatings

    i. The Feed Hopper(s) shall be painted or coated per Supplier's standard specifications. See Section 2.10 – Painting
    ii. The interior of the Hopper(s) shall be epoxy-coated suitable for immersion and corrosion resistance.
    iii. The exterior of the Hopper(s) shall be painted with Supplier's standard colors.

3. Feed Pump

    a. The Feed Pump shall be an open-throat configuration, progressive-cavity style pump designed specifically for pumping of dewatered sludge.

        i. The pump shall be fed dewatered sludge cake from the live-bottom screws of the Hopper(s) and shall be capable of pumping the sludge at any point within the range of sludge conditions described listed in Service Conditions in this Section, with a minimum 20% safety factor.

    b. Materials of construction shall be suitable for the service.

        i. Rotor: tempered C45 steel with ductile chromium coating
        ii. Stator: Nitrile butadiene rubber (NBR)

    c. The driver for the pump shall not exceed 63 rpm design speed at the maximum volumetric pumping rate and shall include:

        i. Motor: Inverter grade, 1800 rpm
        ii. Variable-frequency drive (VFD)
        iii. Gear reducer

    d. High pressure-, over-temperature- and run-dry protection shall be provided for the pump.
    e. Fabrication and installation of the discharge piping from the Feed Pump to the Dryer shall be provided by the Contractor.
    f. The Feed Pump shall be Seepex or equal.
    g. Performance and Design Requirements

        i. The pump shall be of the self-priming, positive displacement, progressing cavity-type specifically designed for pumping the specified wastewater solids from the storage hopper to the biosolids dryer, and/or solids loading area as shown on the Drawings, and as specified herein.
        ii. Solids handling pumps shall be specifically designed and selected for continuous duty pumping of liquids with a solids concentration of up to 28% and a pH of 5.0 - 6.5.

iii. The pump shall be of the compact, close-coupled design. The gear reducer shall be sized for a minimum service factor of 1.5 and designed with a thrust load capability of 150 percent of the actual thrust load.
iv. The pump, along with associated drive appurtenances, shall be mounted on commonly fabricated steel baseplates.
v. Manufacturers must currently have installations for the same liquids and of the same size pump unit, in service for a minimum of three years.
vi. Operating Conditions: The Manufacturer shall provide one (1) dewatered soilds (cake) pump at the screw/volute press. The pump shall have a premium efficient motor suitable for variable speed drive and shall be specifically sized/designed/selected by the Manufacturer to work with the biosolids hopper and biosolids dryer system. It is anticipated that the pump will have a capacity of approximately 30 gpm at a differential pressure of 280 psi and 80 rpm (max).

h. Equipment

i. Rotor and Stator: The pump shall be a minimum two-stage design employing a convoluted rotor operating in a similarly convoluted stator. The convolutions shall be configured to form a cavity between the rotor and stator, which shall progress from the pump's inlet to discharge port with the operation of the rotor. The fit between the rotor and stator at the point of contact shall compress the stator material sufficiently to form a seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber. The stator shall be molded with a seal integral to the stator elastomer preventing the metal stator tube and the bonding agent from the elastomer from contacting the pumped liquid. Gaskets or "O" rings may not be used to form this seal. Stators for solids pumps shall have Buna elastomer. The solids pump rotors shall be constructed of tool steel. Additionally, the solids pump rotors shall have a chromium nitride coating (Duktil) with a minimum thickness of 0.010". Hard chrome plating or ceramic coatings are not acceptable due to the ease at which this coating will crack and the lack of diffusion into the rotor base metal.
ii. Rotor and Drive Train: The rotor drive train shall consist of the following:
(i) The pump rotor shall be driven through a positively sealed and lubricated pin joint. The pin joint shall have replaceable bushings, constructed of air-hardened tool steel of 57-60 HRc, in the rotor head and coupling rod. The pin shall be constructed of high-speed steel, air-hardened to 60-65 HRc. The joint shall be grease lubricated with a high temperature (450 F), PTFE-filled synthetic grease, covered with Buna N sleeve, and positively sealed with hose clamps constructed of 304 stainless steel. A stainless steel shell shall cover the rotor side universal joint assembly to protect the elastomer sleeve from being damaged by tramp metals or glass. The universal joints shall carry a separate warranty of 10,000 operating hours. This warranty shall be unconditional in regards to damage or wear.
iii. Casing: A 300 - pound (ANSI B16.5) flanged connection shall be provided at the discharge port. The discharge casings shall each be provided with a 3/8-inch (or larger) tap to permit the installation of pressure instruments. The suction casing shall be fabricated from a corrosion-resistant steel plate and designed with a rectangular opening. The suction casing shall incorporate a conical "extension tube" between the hopper opening and the rotor and stator. A single helix ribbon auger shall run the entire length of the suction casing. The ribbon auger shall turn concentrically in the hopper. The auger shall be driven

by the main pump drive gear motor. The ribbon auger and extension tube work in concert to apply additional shearing forces against the thixotropic solids to reduce the apparent viscosity of the material, minimize air entrainment and improve the volumetric efficiency of the pumping elements. The walls of the hopper shall be vertical to minimize bridging.

iv. Shaft Seals and Bearings: The pump shall be provided with oil-lubricated thrust and radial bearings, located in the gear motor, designed for all loads imposed by the specified service. The shaft shall be sealed with a minimum of 5 rings of packing. The packing gland shall have a grease fitting when required.

v. Motor and Drive Unit:

(i) Gear motors or gear reducers shall be designed per AGMA 6019-E (Class II). Unless otherwise noted, motors shall be energy-efficient, TEFC.

(ii) For ASD-driven units, the pump supplier shall be responsible for the provision of the fixed reduction between the motor and pump. The reduction ratio shall be that required to operate the pump at its maximum operating speed when the motor is operating at its nominal rated full speed. ASD-driven units may be operated at up to 80 Hz at the maximum speed.

i. Accessories:

i. Run Dry Protection: PT-100 consisting of sensor sleeve fitted to the stator of the pump. Sensor is mounted in IP55 connection head installed in the pump stator. The PT-100 is provided without TSE controller. Dryer Manufacturer will connect the PT-100 to their PLC. The PLC controller shall monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller.

ii. Over Pressure Protection:

(i) The pump unit shall be supplied with a silicone-filled isolation ring with a dual-mounted gauge and single-point pressure switch.

(ii) The pressure ranges for the switch and gauge shall be selected specifically for each specified service.

(iii) The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans, and be constructed with a carbon steel body and fittings with a Buna sleeve.

(iv) The switch shall be SPDT, NEMA 4.

j. Standby Components: The following components shall be furnished:

i. One set of special tools shall be provided to service the pumps.

ii. One (1) stator assembly with TSE sensor sleeve

iii. One (1) rotor

iv. One (1) set universal joint assemblies

v. One (2) set packing

B. Thermal Fluid Heating System

1. General

a. The Thermal-Fluid Heating System shall be skid-mounted, pre-wired, pre-plumbed and factory tested to facilitate installation.

b. The Thermal-Fluid Heating System shall be located generally as shown on the Drawings, allowing for personnel access and maintenance clearances as indicated.
c. The primary fuel source for the Thermal Fluid Heater shall be natural gas.

    i. A dedicated fuel-gas flow/totalizer shall be provided **by others**.

d. Combustion gases from the heater to be ducted out of the building to a stack.

    i. The stack and connection to the Heater flue shall be provided **by others**.
    ii. The stack shall include a barometric damper **by others**.

e. The Thermal Fluid System shall include a “Cooldown” mode in which the burner is off (not firing) and the Combustion-Air Blower and the Thermal-Fluid Pump are operated simultaneously to dissipate heat from the Dryer System at maximum rate.
f. All components of the Thermal-Fluid System shall be coated with a high-temperature paint rated for at least 850°F, Flame Control 850 Series, per Supplier’s standard specifications or equivalent.
g. Thermal fluid shall be Paratherm NF or equivalent. The Thermal Fluid shall be a non-toxic, mineral-oil based heat-transfer fluid rated for use in closed-loop systems to 600°F. The fluid shall have a flash point above 300°F and a boiling point above 649°F.

2. Thermal Fluid System Local Panel

a. The Panel shall be a NEMA-12 enclosure mounted and pre-wired on the Heater skid.
b. The Panel shall include the flame-failure system and all other controls necessary for safe operation as specified in this Section.
c. The Panel shall include the following features and controls:

    i. Status indicator lights
    ii. Audible alarm horn
    iii. Output signals to the Dryer System Control Panel:
        (i) BMS alarm
        (ii) Thermal-Fluid Pump alarm
        (iii) Stack high-temperature alarm
        (iv) Burner on
        (v) Thermal-Fluid Pump on
        (vi) Heater outlet temperature (analog)
        (vii) Stack temperature (analog)
    iv. Input signals to the Dryer System Control Panel:
        (i) Heater System start/stop
        (ii) Pump start
        (iii) Burner start/stop
        (iv) Cooldown mode start
        (v) Firing rate (analog)

3. Thermal-Fluid Heater

a. The Heater shall be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

i. The heater shall be suitable for design temperature and pressure as required by the Biosolids Dryer.
ii. The Heater shall have an ASME code stamp.
iii. The Heater shall include one or more pressure-relief valves on the discharge of the Heater with a relief setting not exceeding the maximum allowable working pressure (MAWP) of the Dryer.

b. The burner shall meet the following requirements:

i. The burner shall be designed to not exceed 85 ppmv NOx as measured and corrected at the stack.
ii. The burner shall meet or exceed all applicable codes and regulations and shall be arranged and piped to ASME CSD 1 and Factory Mutual standards.
iii. Combustion-air and fuel-gas trains shall be in accordance with NFPA standards and all applicable codes.
iv. The burner shall be forced draft and provided with a combustion-air blower.
v. The burner shall be sized for the maximum and minimum heating loads with 10:1 modulation turndown ratio.
vi. The burner shall include a flame-failure system including:
(i) Ultraviolet flame sensor
(ii) Burner Management System (BMS), Siemens LMV5x or equal.
(iii) High- and low fuel-gas pressure switches.

c. The heat exchanger coil shall meet the following requirements:

i. The maximum allowable working pressure (MAWP) shall be 150 psig at 650°F.
ii. Materials of construction: SA106B.

4. Thermal-Fluid Pump

a. The Pump shall be a centrifugal pump with

i. The Pump shall include ball bearings and air-cooled mechanical seals.

b. The Pump shall be suitable for design flow, temperature and pressure as required by the Biosolids Dryer.
c. Materials of construction:

i. Casing: ductile iron
ii. Impeller: cast iron
iii. Seal: 316 stainless steel/Silicon carbide

5. Thermal-Fluid Piping

a. Piping shall be designed in accordance with the ANSI Power Piping Code, B31.1.
b. Valves shall be rated for thermal fluid duty and shall include stainless steel bellows seals.
c. Where required to accommodate thermal expansion, flexible hoses shall be 316 stainless-steel corrugated hoses with external 304 stainless-steel braided reinforcement.

6. Expansion and Catch Tanks

a. The Expansion Tank shall be sized for 200 percent (200%) of the estimated change in thermal-fluid volume between ambient and operating temperature.
b. The Expansion Tank shall be designed to function as a de-aerator and operate at near atmospheric pressure. The expansion tank shall have a nitrogen blanketing system to reduce oxidative stress. The Expansion Tank shall vent to the Catch Tank.
c. Vent, drain, overflow and discharge lines from the Expansion Tank and thermal-fluid pressure relief valves shall be routed to the Catch Tank.

    i. The Catch Tank shall be operated dry.
    ii. The Catch Tank shall vent to a safe location outside the building. Vent piping shall be provided by the Contractor.
d. The Expansion and Catch Tanks shall be constructed of carbon steel.

7. The Thermal-Fluid Heater System shall be manufactured by Fulton or equal.

B. Dryer

1. General:

a. The Dryer shall be designed to operate with an oxygen-deficient atmosphere.
b. The Dryer shall consist of two (2) parallel, hollow-flite augers units and a jacketed enclosure. The Auger shall be 30” diameter at the minimum
    i. Total heat exchange area shall be not less than 1090 square feet.
c. The Dryer shall be heated with thermal fluid as described in this Section.
d. The Dryer Auger shall be subjected to Finite Element Analysis (FEA) Fatigue stress assessment. The objective of this analysis is to confirm design through the finite element analysis (FEA) method and show that the augers will conform to the design and fatigue specifications for a 40-year service life as per ASME best practices.
e. The Dryer shall be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

    i. Each component of the Dryer containing thermal fluid under pressure, such as housing jacket, & auger, shall have an ASME code stamp.
    ii. Materials of construction (heated): Carbon steel.

f. The Dryer shall be skid-mounted on a single base/frame constructed of A36 carbon steel to provide support for the shaft bearings, drive assembly and any ancillary equipment, piping, instrumentation, and local control panels.

    i. The base/frame shall be supported by legs constructed of A36 carbon steel provided by the Supplier.

        (i) The platform and stairs shall be pre-manufactured and erected with only bolting or other fasteners at time of erection in the field.

        (ii) Platforms shall include steel bar grating, with stainless steel locking fasteners, toe boards or kickplate, and bolted handrail. Platform structure shall be steel, with floor interface brackets designed for ½” anchor bolting (by others).

        (iii) Stairs’ structure shall be fabricated of steel, with bar grating treads/risers and stainless-steel locking fasteners, with bolted handrails.

(iv) Materials of construction shall be steel, with minimum coating of hot dip galvanized, with exception to safety yellow painted surfaces as per code, which shall be epoxy/urethane or powder coated.

g. Bio Solids dryer shall include below features as a minimum

i. Reversible auger to enhance mixing and heat transfer.
ii. The augers units shall be equipped with tabs to promote local solids mixing and heat transfer.
iii. Independent-driven augers with absolute position encoders and controls which permit relative speed control and close approach of flights to facilitate solids mixing and surface cleaning.
iv. Independent-driven augers also allows for Pause or “Rock mode” up to 30 minutes, without feed and without discharging material, to allow operators to remove or replace storage containers (trailers, bins, Super-Saks, etc.).

2. Safety Requirements: To prevent deflagrations and emissions and in conformance with the Supplier’s Safety Management Plan:

a. The Dryer shall include remotely actuated water sprays and controls to quench temperatures for deluge.
b. The Dryer shall include a continuous nitrogen purge and controls as required to generate and maintain an inert (non-oxidizing) atmosphere within the Dryer.
c. Per the requirements of NFPA 68, Chapter 7: “Deflagration Prevention by Oxidant Concentration Reduction”, the Dryer shall include a sensor to monitor oxygen concentration inside the Dryer housing.
d. The Dryer housing shall have sufficient void space above the operating level of wet/dry sludge to allow for removal of vapors at a superficial velocity the lesser of 1.5 meter/second or 20% of the estimated entrainment velocity to minimize dust entrainment and the associated hazards. The Supplier shall submit calculations with the Safety Management Plan to the Engineer as part of the action submittals.
e. The Dryer shall be designed as a closed, sealed system to minimize air leakage into the Dryer and shall operate at a slight negative pressure to prevent emission of odors.

3. Dryer Enclosure

a. One (1) enclosure with a smooth inner surface and external jacket integrally welded to the enclosure wall.

i. The lower trough of the enclosure shall be configured to allow inter-meshing of the auger and a nominal clearance of ½” (inch) or less between the augers and enclosure.

b. End cover plates shall include stuffing boxes to provide shaft seals and permit removal of the auger/agitator shaft(s).

i. Stuffing boxes shall include ports for application of lubricant

c. The Dryer shall include the following process nozzles:

i. The dryer chamber shall include at least three (3) top-mounted, flanged rectangular inspection ports.

ii. Two (2) end-cover-mounted flanged access ports.
iii. One (1) 8” (inch) flanged round nozzle, Class 300, on one end-cover access port for sludge feed.
iv. One (1) top-mounted flanged rectangular nozzle at the feed end for the vapor vent.
v. One (1) bottom-mounted flanged rectangular nozzle opposite the feed end, for dried product.
vi. Multiple thermocouple nozzles located along the length of the dryer, top and bottom, to monitor solids and vapor temperature for process control and compliance verification.

d. Prior to insulation, the Dryer housing shall primer-painted with one coat high temperature paint.
e. The Dryer housing shall be insulated and cladded with stainless-steel sheet metal to maintain the outer surface temperature < 140°F.

4. Dryer Augers:

a. Two (2) shaft-mounted, heated, inter-meshed and counter-rotating augers fabricated with hollow cavities and baffling to permit flow of heat-transfer fluid.
b. One end of each shaft shall be hollow to permit the passage of thermal fluid into and out of the auger.

i. Each shaft shall be equipped with a dual-port, rotary union, Kadant ELSJA or equivalent.

ii. The fixed/rotary seal design shall be spring loaded to maintain seal pressure, and the seal ring shall be carbon impregnated with antimony with front and rear carbon guides.
iii. The shaft shall be supported by a precision split graphite bearing.

c. One end of each shaft shall be solid to permit attachment of a gear reducer and a motor.

i. The motor shall be rated for inverter duty.
ii. The gear reducer shall be manufactured by Dodge or equal, and shall include an absolute-position encoder to monitor shaft rotational position.
iii. The shaft shall be supported with lubricated spherical roller bearing.

C. Inert-Gas Purge System

1. As per the Supplier’s Safety Management Plan, the Supplier shall provide an inert-gas (nitrogen or equivalent) purge system to purge or blanket the dryer.
2. The Supplier shall provide all necessary appurtenances, including but not limited to, regulator, valves, gauges, switches and controls for safe and effective operation of the System.

a. The Purge System shall be factory wired and plumbed to the Dryer skid to maximum extent possible.
b. The inert-gas supply piping shall be provided by others.

D. Vapor Condenser

1. General:

a. The Supplier shall provide a multi-stage, direct-contact spray condenser using plant cooling water to condense the Dryer vapors.

i. The cooling water/condensate mixture and the exhaust vapor shall not exceed 140°F.

b. Materials of Construction:

i. Wetted vessel materials shall be Type 304 stainless steel.
ii. Internal piping shall be Type 304 stainless steel.
iii. Spray nozzles shall be Type 316 stainless steel.

c. The Condenser shall include a flanged inspection ports for each spray nozzle.
d. The Supplier shall provide a switch or transmitter for the cooling water flow to the Condenser.

i. The flow signal shall be a permissive signal for Dryer startup.

2. Separator

a. The Supplier shall provide a gas-liquid Separator to remove and collect the cooling water/condensate from the Condenser exhaust stream.

i. The Separator shall include an internal liquid trap to prevent foul-air vapors from exiting the bottom drain nozzle and entering the drainage system.
ii. Wetted vessel materials shall be Type 304 stainless steel.
iii. The Separator shall include a flanged inspection port.

E. Foul-Air Fan

1. The Supplier shall provide a Foul-Air fan to withdraw non-condensable vapors from the Condenser and forward to the Odor-Control System.

a. The Fan shall be variable speed to control Dryer pressure.
b. The Fan shall include:

i. Fiberglass-reinforced plastic (FRP) casing and impeller.
ii. Stainless steel shaft with Viton seal.
iii. Inverter-duty motor.

c. Piping between the Condenser and the Foul-Air Fan shall be provided by the Supplier. Piping material shall be Type 304 stainless steel.

F. Discharge Conveyor

1. General:

a. Conveyor operation shall be linked to dryer operation and startup/shutdown processes and shall be interlocked to prevent any unit from operating if any of the downstream conveyors are not operating. During a shutdown, the conveyors shall operate for an adjustable time period after the dryer is shut down to assure that they have been cleared of dried biosolids. Full function of downstream conveyance shall be a permissive for operation of the Dryer.

2. Description:

a. The Discharge Conveyor housing shall be closed and circular. A covered U-trough design is not permitted.
b. Discharge Conveyor housing shall be Stainless Steel 304 materials of construction.
c. The Discharge Conveyor tubular housing shall be insulated with removable blankets consisting or 1" (inch) mineral wool insulation covered with a polyester fabric to maintain the outer surface temperature below 140°F.
d. The auger shall be hollow-shaft, solid flight. Materials of construction shall be SA-36 and SA-106-B carbon steel.

i. Flights at the inlet shall be tapered to prevent compacting of the dried solids and plugging.
ii. Shaft bearings shall be sealed Dodge, Type E roller, or equivalent.
iii. Shaft seals shall be lubricated CEMA labyrinth.

e. The Discharge Conveyor shall include a variable speed gear-motor drive.

i. The motor shall be inverter duty and controlled by a VFD.
ii. The gear reducer shall be manufactured by Nord, SEW or equal.

f. The Discharge Conveyor shall be direct-connected and suspended from the Dryer. It shall also be supported on the Cooling Conveyor inlet flange.

G. Cooling Conveyor

1. General:

a. Product cooling shall be provided to cool the dried biosolids as stated in the Performance Requirements prior to storage or load-out.

i. Cooled biosolids shall not exceed the lesser of the temperature as stated under Performance Requirements listed in this Section or 120°F.
ii. The cooling water supply line to the Cooling Conveyor shall include an actuated shut-off valve (SOV).

(i) Cooling water shall flow in series from jacket to auger before discharge.

b. Product coolers shall be designed assuming plant effluent will be the cooling medium. The maximum temperature of the plant effluent will be as stated under Service Conditions listed in this Section.
c. To prevent air intrusion into the Dryer, the Cooling Conveyor shall include a Rotary air lock Valve on the outlet.
d. Conveyor operation shall be linked to dryer operation and startup/shutdown processes and shall be interlocked to prevent any unit from operating if any of the downstream conveyors are not operating. During a shutdown, the conveyors shall operate for an adjustable time period after the dryer is shut down to assure that they have been cleared of dried biosolids Full function of downstream conveyance shall be a permissive for operation of the Dryer.

2. Description:

a. The Cooling Conveyor housing shall be closed and tubular. A covered U-trough design is not permitted.

b. The Cooling Conveyor shall be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

    i. Each component of the Cooling Conveyor containing water under pressure, such as the housing and auger, shall have an ASME code stamp.

c. The housing shall be jacketed. Materials of construction shall be SA-53 and SA-36 carbon steel.
d. The auger shall be hollow-shaft, solid flight. Materials of construction shall be 304 stainless steel.

    i. One end of each shaft shall be hollow to permit the passage of cooling water into and out of the auger.

        (i) Each shaft shall be equipped with a dual-port, rotary union, Kadant ELS or equivalent.
        (ii) Shaft bearings shall be sealed Dodge, Type E roller, or equivalent.
        (iii) Shaft seals shall be lubricated CEMA labyrinth.

e. The Cooling Conveyor shall include a variable speed gear-motor drive.

    i. The motor shall be inverter duty and controlled by a VFD.
    ii. The gear reducer shall be manufactured by Nord, SEW or equal.

f. A temperature sensor shall be provided in the Cooling Conveyor discharge.
g. The Cooling conveyor shall include a floor-mounted base at the inlet end and the Supplier shall provide a vertical, floor-mounted stanchion to support the Cooling conveyor at the discharge end.
h. The Cooling Conveyor housing shall be coated per painting specifications listed in the Section 2.10 Painting.
i. The Cooling Conveyor shall include a motor/chain-driven Rotary Valve at the outlet.

    i. Materials of construction shall be carbon steel rotor, stainless-steel housing, and UHMWPE wipers.

H. Dried Product Loadout system

1. General

a. The cooled dried product from the cooling conveyor discharge shall go to either the Pellet mill feed hopper or to the bypass conveyor via diverter valve.
b. The diverter valve and the bypass conveyor are controlled by the dryer control system.
c. Any dust generated during the conveyance, shall be removed via suction pickups along the conveyor. Supplier shall supply minimum of 5’ of flexible, antistatic, grounded, clear ducting to connect to the ducting trunk/manifold (by Others) to the wet dust separator.
d. Bypass Conveyor operation shall be linked to dryer operation and startup/shutdown processes. During a shutdown, the conveyors shall operate for an adjustable time period after the dryer is shut down to assure that they have been cleared of dried biosolids. Full function of downstream conveyance shall be a permissive for operation of the Dryer.

2. Diverter Valve with Bifurcated Chute

   a. The diverter valve shall include flap gate with shaft & flange bearings. All process contact material shall be Type 304 stainless steel.
   b. The Bifurcated chute shall be made with 11 ga Type 304 stainless steel.
   c. All Fastener & Hardware shall be Type 304 stainless steel.
   d. Actuator – Electric type shall be linear or quarter turn, Rotork IQ or equal, with position feedback switches. The actuator enclosure should be rated for hazard area classification.

3. Bypass Conveyor

   a. The Conveyor shall be shafted type – 9" diameter X ±35' long inclined.
   b. The conveyor housing shall be U trough with drains & stiffeners as required and bolted cover.
   c. The conveyor screw shaft shall be 2 ½" SCH 40 pipe with 9" dia. x 9" pitch x 3/16" thick sectional flights, mounted on.
   d. The conveyor material shall be Type 304 Stainless steel. The U trough, inlet & discharge chutes are 11 ga, while the cover shall be 14 ga. All Fasteners & Hardware shall be Type 304 Stainless steel
   e. The Bypass Conveyor shall include a constant speed gear-motor drive.

      i. The motor shall be 460VAC/3P/60 Hz, 1800 RPM suitable for hazard area location.

      ii. Drive shall be AGMA Class II service FA conveyor gearbox reducer, shaft mount style, mounting frame, & packing gland. The drive system shall be manufactured by Nord, SEW or equal.

   f. The Bypass conveyor shall include local emergency stop switch w/cable and zero speed switch interlocked in the dryer process control system.

I. Pelletizer Equipment

1. General

   a. The Pelletizing System shall be skid-mounted, pre-wired, pre-plumbed to maximum extent possible and factory tested.
   b. The Pelletizing System shall be located generally as shown on the Drawings, allowing for personnel access and maintenance clearances as indicated.
   c. Any dust generated during the formation of pellets, including partial pellets during equipment startup, shall be removed via suction pickups on each piece of equipment. Supplier shall supply minimum of 5' of flexible, antistatic, grounded, clear ducting to connect to the ducting trunk/manifold (by Others) to the supplied wet dust separator.

      i. The duct pickups from each equipment, and trunk shall be **by others**
      ii. The design of the duct shall always maintain air flow above 4000 fpm, for positive conveyance, total air flow is 4000 cfm.

2. Pelletizer System Local Control Panel(s)

   a. The Panel(s) mounted at the system location shall be a NEMA4x enclosure(s) mounted and pre-wired on the Pelletizer skid.

b. The Panel shall include the local package HMI and all other controls necessary for safe operation as specified in this Section.
c. The Panel shall include the following features and controls:

i. Status indicator lights
ii. Audible alarm horn
iii. Output signals to the Dryer System Control Panel:
(i) Explosion Door Activation Alarm
(ii) Hopper High Level Alarm
(iii) Hopper Low Level Alarm
(iv) General High Temperature Alarm
(v) Pellet Mill Level Alarm
(vi) Pellet Mill Clog Alarm
(vii) Motion Alarm
(viii) Pellet Cooler Level Alarm
(ix) Dust collector no Flow Alarm
iv. Input signals from the Dryer System Control Panel:
(i) Pellet Mill Run Request/Bypass

3. Pellet mill

a. Flat Die type Pellet Mill, with replaceable and flappable Die plate. Replaceable rollers.

b. Sized to process up 1,000 lbs./hr of dry, granular Class A biosolids into ¼" diameter pellets via 12" die.
c. Pellet mill chamber will have at minimum a high-level sensor for blockage detection, a flow sensor on the discharge of the mill and dust collection port in top housing.
d. Safety features will include amp monitoring for pellet mill motor drive, temperature sensor for pellet mill die plate and housing.

4. Feed Hopper

a. A live bottom surge vessel sized for a minimum of 30 minutes solid holding retention to avoid stop/starts on pellet mill. Live bottom motor amp draw monitored to avoid hard particle bridging damage.
b. Fitted with feed auger to transport feed to mill. Feed auger amp draw monitored to avoid hard particle bridging damage.
c. Surge vessel will be equipped with a minimum of level sensors high-high, high, low. Two thermocouples for monitoring solids temperature in vessel. High temperature event activates Nitrogen deluge solenoid valve. Negative pressure indicator for dust collection suction pressure control. Explosion venting sized for the vessel directed away from personal, equipped with operation signal for safety interlock activation.

5. Screening Deck

a. Encapsulated vibratory screener deck, dual type, to remove fines (smaller than target size) and overs (larger than target size) after pellet mill, with combined suction collection trough for over/under removal and spout for product.
b. Transition from Screener to belt conveyor uses a falling stream detector for blockage detection.

6. Cleated Belt Conveyor

    a. Encapsulated cleated belt conveyor on self-supporting wheeled (lockable) stand sized to convey a minimum of 1,000 lbs./hr of pelletized material
    b. Fitted with belt travel sensor for drive train no speed/under speed.
    c. Inlet transition incorporates a pellet temperature sensor.
    d. Dust collection port located at the inlet side of the conveyor.
    e. Equipped with explosion venting with sensor.
    f. Motor amp draw monitored for aberrant conditions.
    g. Fitted with emergency stop switch and pull cables.

7. Pellet Cooler

    a. Inlet flow to pellet cooler isolated with top mounted rotary airlock with product flow sensor below airlock. Airlock drive train zero speed switch integrated.
    b. Cooler is counter flow, triple grid type using ambient air for cooling pellets to <120F, and a funnel to aid in discharge transfer to cleated belt conveyor for conveyance to truck/dumpster.
    c. Fitted with a minimum of Three (3) level sensors within cooler, high-high, high/start, low/off.
    d. Temperature sensor on the pellet discharge and explosion vent equipped with operation signal for safety interlock activation.

8. Single source dust management consisting of wet dust collector with integrated collection fan. Rated for 4,000 CFM and 3-4 GPM**.**
9. Pelletizer Description:
   The cooled, dried material from the cooling screw diverter will feed into the pelletizer feed hopper. The auger is to transport the material to mill the press vertically from above-using gravity without deflectors or other mechanical aids - not forced feed to avoid any blockage or bridging of dried material. The circular path of the rollers on the die causes a shearing effect of the rollers on the product. Due to the frictional forces between the product and the lateral surface of the bore, the wall shear stress on the material inside the effective bore steadily increases until -provided that the effective bore is long enough – it is high enough to compact the product cylinder in the bore gradually into a pellet. The force, which is axially directed downwards by the roller, pushes the additional product into the effective bore to move the already compacted product downwards.
   The individual layers of material forced into the effective bores of the die form an endless strand cut to the desired pellet length from below using an adjustable breaking-off device or knife. The pellet from the mill is discharged to encapsulated vibratory screener deck, dual type, to remove fines (smaller than target size) and overs (larger than target size).
   The screened pellets are conveyed via a cleated belt conveyor to the pellet cooler. The pellet cooler is a counter-current – triple grid type. The pellets are cooled to < 120^{o}F.

J. Cooled Pellet Loadout system

1. General

    a. The cooled pellet from the pellet cooler is conveyed to the diverter valve with trifurcated chute for loading the container designed by others.

b. The diverter valve and the cleated belt conveyor are controlled by the Pelletizer control system.
c. Pellet load out operation shall be linked to pelletizer operation and startup/shutdown processes. During a shutdown, the conveyors shall operate for an adjustable time period after the pelletizer system is shut down to assure that they have been cleared of cooled pellets. Full function of downstream conveyance shall be a permissive for operation of the pelletizer system.

2. Diverter Valve with Trifurcated Chute

a. The diverter valve shall include (2) flap gates with shaft & flange bearings. All process contact material shall be Type 304 stainless steel.
b. The Trifurcated chute shall be made with 11 ga Type 304 stainless steel.
c. All Fastener & Hardware shall be Type 304 stainless steel.
d. Actuator – Electric type shall be linear or quarter turn, Rotork IQ or equal with position feedback switches. The actuator enclosure should be rated for hazard area classification.

3. Pellet Loadout Conveyor

a. The Conveyor shall be side wall belt type– 24” wide x ± 32.5’ OAL pulley CL.
b. The Loadout conveyor system shall include screw type take up to move the cooled pellets from the cooler to belt conveyor. The take up assembly shall be made of Type 304 stainless steel.
c. The conveyor shall include C channel frame, deck plates, drip pans and support. The head & tail pulleys shall be protected by safety guard.
d. The belt shall be 24” wide and MOR PIW 220 4-ply 1/8” x 1/16”. The Sidewall 2” high, with cleats 14” wide x 10” spacing.
e. The idlers for the belt conveyor shall include CEMA C-5- nonmetallic rollers, sealed for life bearing, in Type 304 stainless steel frame.
f. The Head and tail pulley shall be 10” dia. x 28” welded steel, head pulley with herringbone rubber lagging, 1-15/16” shafts, and bearings.
g. The material shall be Type 304 Stainless steel. All Fasteners & Hardware shall be Type 304 Stainless steel
h. The Loadout Conveyor shall include a constant speed gear-motor drive.

i. The motor shall be 460VAC/3P/60 Hz, 1800 RPM suitable for hazard area location.
ii. Drive shall be direct type, gearmotor, gear reducer by Eurodrive or equal with 0.75 fpm output.

i. The Bypass conveyor shall include local emergency stop switch w/cable and zero speed switch interlocked in the dryer process control system.

2.7 PROCESS CONTROL SYSTEM (PCS)

A. Control Panels:

1. The Supplier's control-system development shall be coordinated with the Owner’s plant-wide Control System prior to beginning software development.

2. Dryer System Control Panel: The Supplier shall provide a Control Panel, a Motor Panel, and a UPS Load Panel, Located in either electrical equipment room or any safe area. Supplier shall also provide a Remote I/O (RIO) panel located at the Dryer, and another located in the load out area, as well as a junction box near the Feed System. The packaged Thermal Fluid Heater System shall have a motor load and control panel affixed to its structure. The packaged Pelletizer System shall have a control panel mounted near the pellet mill skid, with a separate motor load panel located in either the electrical equipment room or any safe area.

    a. The RIO Panels (Dryer and Conveyance) and Pelletizer Control Panel shall be NEMA 4X, stainless steel, dust tight.

3. The Dryer System Control Panel shall be a wall mounted enclosure, to house the controls equipment, with no components energized with greater than 120VAC power. The Dryer System Motor Panel shall be a freestanding enclosure, to house the controls motor starters, power distribution and VFD equipment. The right-hand compartment shall house all equipment and wiring at and above 120VAC, including the following:

    a. A main circuit breaker with a through-the-door or flange-mounted lockable handle. This breaker shall serve as a single point 480VAC, three-phase power connection to the panel, and all other power and control required shall be derived from this single source via the necessary branch breakers and step-down transformers. Exceptions shall include:

        i. Controls and equipment powered by an external 120VAC uninterruptable power supply (UPS) as described in this Section.
        ii. Thermal Fluid System Local Panel.

    b. VFDs for all variable-speed motors provided under this Section.
    c. Motor starters with overloads for all constant speed motors provided under this Section.
    d. A 120VAC, single-phase power feed from building distribution will feed a separate UPS panel. The UPS will be supplied to power all DC power supplies, PLC, Ethernet switches, the HMI display terminal, and any critical safety equipment such as purge/deluge valves, fire monitoring systems, etc.
    e. The main circuit breaker shall be a symmetrical thermal-magnetic breaker sized in accordance with System requirements.

4. The Dryer RIO panel shall be a rack mounted NEMA 4X enclosure located at the Dryer skid. The RIO panel shall house Allen Bradley Point I/O. All skid instrumentation used to monitor Dryer process conditions and control local valves shall be marshalled to the RIO panel. Power to the RIO panel shall originate from the UPS. The RIO panel shall include an Ethernet adaptor to communicate with the Dryer Control panel. If required by the Safety Management Plan, an inert gas purge kit shall be installed on the RIO panel to meet NEC Class II, Division II Hazardous area requirements.
5. The Conveyance RIO panel shall be a rack mounted NEMA 4X enclosure located at the load out area. The RIO panel shall house Allen Bradley Point I/O. All instrumentation used to monitor conveyor process conditions and control local valves shall be marshalled to the RIO panel. Power to the RIO panel shall originate

from the UPS. The RIO panel shall include an Ethernet adaptor to communicate with the Dryer Control panel. If required by the Safety Management Plan, an inert gas purge kit shall be installed on the RIO panel to meet NEC Class II, Division II Hazardous area requirements.

6. The Pelletizer RIO panel shall be a rack mounted NEMA 4X enclosure located at the load out area. The RIO panel shall house Allen Bradley Point I/O. All instrumentation used to monitor pelletizer process conditions and controls shall be marshalled to the RIO panel. Power to the RIO panel shall originate from the UPS. The RIO panel shall include an Ethernet adaptor to communicate with the Pelletizer Control panel. If required by the Safety Management Plan, an inert gas purge kit shall be installed on the RIO panel to meet NEC Class II, Division II Hazardous area requirements.
7. The Pelletizer control panel shall be a rack mounted NEMA 12 enclosure located adjacent to the dryer control panel. The panel shall house Allen Bradley Compact or MicroLogix PLC with I/O. All instrumentation used to monitor pelletizer process conditions and control local valves and equipment shall be marshalled to the panel. Power to the panel shall originate from the UPS. The panel shall include an Ethernet adaptor to communicate with the Dryer Control panel.
8. The Thermal Fluid System Local Panel shall be a rack-mounted enclosure to house the control equipment for the Thermal Fluid System. It shall contain, at a minimum, the following:

    a. A main circuit breaker with a through-the-door lockable handle. This breaker shall serve as a single-point 480VAC, three-phase, three-wire power connection to the panel, and all other power and control required shall be derived from this single source via the necessary branch breakers and step-down transformers. The 480VAC main power connection shall be from the Owner's MCC or distribution.
    b. Motor starters with overloads for all constant speed motors provided under this Section.
    c. Step down transformer to supply the Thermal Fluid System separate control panel and instruments.

B. Controls

1. The controls for all components of the System shall be provided by a dedicated programmable logic controller (PLC) mounted in the Dryer System Control Panel.
    a. The PLC shall be, without exception, Allen-Bradley CompactLogix series.
    b. The PLC shall provide all control and monitoring functions as required for the operation and monitoring of the System including, but not limited to, timing, interlocks, permissive functions, startup sequencing, normal- and emergency shutdowns required for safe operation.
    c. The PLC shall communicate with the Owner's plant-wide control system via Ethernet/IP as specified herein. Ethernet connection between the PLC and the plant-wide control system shall be separate from the Control Panel Remote I/O Ethernet network.
    d. To allow Supplier remote access to the PLC and HMI via VPN for maintenance and support, a ethernet router shall be included.

2. Human Machine Interface (HMI):

a. The HMI shall be a 19-inch industrial touch panel, coupled to an internally mounted, fan less, industrial PC running SCADA software.
b. The SCADA software will be capable of data historian function, with local storage provided, and options for remote data storage (by others or BCR service agreement).
c. The panel mounted HMI shall provide the primary method for an operator to monitor the status of the System and to affect its operation by command or directive entry. A PDA/tablet with wireless (WIFI only) access shall also be provided as a mobile HMI alternative to monitor and control the System. The HMI shall provide the Graphics User Interface between the operator and the PLC that controls the functions of the System. The graphics and their layout/presentation shall be by the Supplier and configured specifically for the System covered under this Section.
d. The HMI shall provide all displays and control screens needed to monitor and control the System safely and efficiently.
e. At a minimum, the HMI shall provide for selection of the following:

    i. System Control Mode: LOCAL-REMOTE
    ii. System AUTO-START
    iii. Sludge Feed Rate Setpoint (0-100%)
    iv. Setpoints for all critical temperatures as recommended by the Supplier.
    v. System AUTO-STOP
    vi. System EMERGENCY-STOP
    vii. System PAUSE
    viii. System RUN (un-pause)
    ix. Adjustable set-points to be defined by the Supplier.

f. Display and make the associated signals available to the Owner's plant-wide control system via Ethernet:

    i. Warning and Fault Alarms, including but not limited to:

        (i) Feed Hopper(s) LOW level
        (ii) Feed Hopper(s) HIGH-HIGH level (to stop feed to Hopper(s))
        (iii) Start or Stop Sequencer Failure

    ii. Status of each system component
    iii. All system temperatures including:

        (i) Dryer
        (ii) Dryer thermal fluid supply and return
        (iii) Thermal-Fluid Heater System
        (iv) Stack
        (v) Cooling Conveyor Discharge
        (vi) Condenser
        (vii) Cooling Water

    iv. Speed of each VFD
    v. Dryer auger VFD current
    vi. Sludge Level in the Feed Hopper(s)
    vii. Thermal Fluid System status
    viii. Status of safety systems including inert-gas purge and water sprays

ix. Status of system components NOT is automatic mode
x. Sequence Step
xi. Sequence Timers

g. Display signals from the Owner's plant-wide control system via Ethernet including:

i. Thermal-Fluid System AUTO-START
ii. System AUTO-STOP
iii. System PAUSE
iv. System RUN (un-pause)
v. Sludge Feed Rate Setpoint (0-100%)
vi. System Power FAILURE
vii. Setpoints for all critical temperatures as recommended by the Supplier.

C. Sequencing:

1. The PLC shall contain all programming necessary to safely start, stop, and operate the System, in either the LOCAL or REMOTE mode. The following minimum conditions and sequences shall be provided.

a. The control system shall confirm the successful initiation and/or completion of each step in the sequence before continuing with the next step in the sequence.
b. Proper sequencing shall be as required by the Supplier to meet the conditions of the Safety Management Plan, and the overall operational plan outlined herein.
c. If any step in this sequence fails, the PLC shall generate an alarm specifying the failed step.

2. In LOCAL mode, System control shall only be available through the Dryer System Control Panel. All outputs to PCS shall still be available in LOCAL mode.
3. In REMOTE mode, AUTO-START, AUTO-STOP, EMERGENCY STOP and process control setpoints shall be from the PCS.
4. AUTO-START: This command shall instruct the control system to begin the start sequence. The system shall begin the controlled heat-up cycle, and permissive shall be employed to prevent undesirable or unsafe conditions from occurring.
5. AUTO-STOP: This command shall instruct the control system to begin its normal shutdown sequence. The AUTO-STOP sequence shall also be initiated by any of the following conditions:

a. Dryer Cake Bin Level LOW-LOW (LL) (LOW level shall be alarm only).

6. EMERGENCY-STOP: This command shall be either manually initiated through the PCS or locally at the Dryer System Control Panel or shall be initiated by an emergency condition occurring that may cause unsafe operating conditions or may damage the equipment.

a. Definition of these emergency conditions shall be documented in the Safety Management Plan.

7. PAUSE: This command shall instruct the control system to stop feed to the Dryer and stop the discharge of dried biosolids for a limited time to permit changing or replacing the dried product load-out container.

a. PAUSE duration shall be limited to a maximum of 30 minutes.

b. After such time, if the system has not been placed back into RUN mode, the AUTO-STOP sequence shall be initiated.
c. The Supplier shall define the proper sequence of conditions/events for the PAUSE function, which shall be documented in the Safety Management Plan.

2.8 ELECTRICAL

A. General:

1. The Supplier shall provide all necessary electrical components and skid mounted wiring for a complete, functional system.
2. All Variable Frequency Drives and motor starters for the System shall be provided in the Dryer Motor Panel provided as part of this Section.

B. Wiring: All conductors shall conform to the requirements of NFPA 70, the 2023 National Electrical Code.

1. Equipment skids shall be Factory pre-wired using extended-reach tray cable and terminated from skid-mounted devices to skid-mounted junction boxes.

a. Electrical schematics and wiring requirements shall be included with the action submittals.

2. Raceways and Conduits:

a. All cables shall be supported in aluminum trays, open-ended rigid conduit and/or approved cable supports.
b. The use of flexible, nonmetallic, liquid-tight conduits shall be limited to less than 36” in length where required.
c. DC signals and power circuits shall not be run in the same cable tray without physical separators, or cable integral shielding rated for the supplied EMF from local power cables.

3. Junction Boxes: All skid-mounted electrical devices and instrumentation, except for motor leads, shall be prewired to skid-mounted Junction Boxes. Separate Junction Boxes shall be used for AC and DC power supply and signals:

C. Motor type shall be suitable for the hazardous-area classification in which they are installed. Refer to the Drawings for area classifications.

2.9 ACCESSORIES

A. Equipment Identification Plates: The Supplier shall provide a 16-gauge, stainless-steel identification plates with component number (tag number) for all equipment and instruments, securely mounted on the equipment in a readily visible location. The plate shall bear the ¼” (inch) die-stamped, identification tag numbers as indicated in this Specification or as shown on the Drawings.

B. Lifting: Equipment and each component thereof weighing over fifty (50) pounds shall be provided with a means for securely handling, lifting or setting.

1. Lifting lugs, lifting eyes or slots for fork-truck tines to facilitate handling.
2. Piping spools or appurtenances are specifically excluded from this requirement.

C. Anchor Bolts:

1. Minimum ½” (inch) diameter, unless a larger size is shown on the Drawings.
2. Anchoring, seismic and foundation design shall be provided by the Contractor or others.

    a. The Supplier shall provide anchor-bolt locations for each equipment component requiring a foundation or attachment to the floor. The Supplier shall also provide an anchor-bolt hole with a diameter at least 1/8” (inch) larger than the required anchor-bolt diameter as determined by the Engineer.

3. Anchor bolts shall be provided and installed by the Contractor.

    a. Anchor bolts shall be minimum Grade B7.

2.10 PAINTING

A. General requirements:

1. Unless specified otherwise, surface-prepare, prime and finish coat exposed/exterior ferrous-metal surfaces for all equipment and accessories of the Biosolids Drying System.
2. Coating systems requiring primer- and finish coats shall be provided by the same paint manufacturer and specified as compatible for the application.
3. Supplier shall provide written thickness test results for each equipment component.

B. Low-Temperature Coatings: For equipment with a surface temperature below 200°F, a standard coating system shall be provided.

1. Preparation: In accordance with the paint manufacturer's written specifications, minimum surface preparation shall include solvent cleaning, SSPC SP-1 followed by abrasive blasting to near white metal, SSPC SP-10. Other surface preparation methods may be approved by the Engineer, provided that the method results in the minimum surface profile required by the paint manufacturer.
2. Coatings

    a. Primer: One (1) coat lead-free, catalyzed epoxy polyamide metal primer 3 mils minimum dry film thickness (DFT)
    b. Finish: One (1) coat aliphatic acrylic urethane, 3 mils minimum DFT.
    c. Other coating systems may be used provided they are submitted to- and approved by the Engineer in advance.
    d. Color shall be the Supplier’s standard.

C. Medium-Temperature Coatings: For equipment with a surface temperature between 200°F and 450°F, a suitable thermal coating system shall be provided.

1. Preparation: As described above under Low-Temperature Coatings.
2. Coatings

    a. Primer: One (1) coat inorganic zinc primer, 2.5 mils minimum DFT.
    b. Finish: Two (2) coats silicone acrylic, 2.0 mils minimum DFT.
    c. Other coating systems may be used provided they are submitted to- and approved by the Engineer in advance.
    d. Color shall be the Supplier’s standard.

D. High-Temperature Coatings: For equipment with a surface temperature above 450°F, a suitable thermal coating system shall be provided.

1. Preparation: As described above under Low-Temperature Coatings.
2. Coatings
   a. Primer: One (1) coat inorganic zinc primer, 2.5 mils minimum DFT.
   b. Finish: One (1) coat silicone, 2.0 mils minimum DFT. Prepare all surfaces and apply all paint.
   c. Other coating systems may be used provided they are submitted to- and approved by the Engineer in advance.
   d. Color shall be the Supplier's standard.

2.11 SPARE PARTS

A. General requirements:

1. Supplier will generate a complete spare parts list during detailed engineering. The spare parts shall be identified as falling in the following categories:
   a. **Installation and commissioning spare parts**: these parts should be kept on hand and available during the system commissioning.
   b. **Recommended capital spare parts**: these parts should be in the inventory on site for the first two years of dryer system operation.
   c. **Required critical Spare Parts**: In addition to above two categories, spare parts list shall identify parts that are critical to the dryer system operation (uptime) shall be identified as "critical spare parts". Typically, these are not available from distributor such as custom fabricated parts or long lead time. As a minimum, the following critical spare parts shall be required for the dryer.

Item No.:	Spare Parts Description	Units per System	Total per System	QTY Recommende
1	Rotary union, rebuild kit (carbon seal, split rings, gaskets)	set	2	2
2	Rotary joint Q gasket Aluminum	set	2	2
3	Tail End Bearing Insert, Graphite Sleeve	ea	2	2
4	Type K, Thermocouple, 12"	ea	5	1
5	Solenoid Valve – Deluge Water	ea	1	1
6	Packing ring, 1/2" square braided graphite-impregnated rope	Ft	25	25
7	Material Level Sensor	ea	1	1
8	Dryer Chamber Pressure Transmitter	ea	1	1

PART 3 - EXECUTION

3.1 INSPECTION AND TESTING

A. General requirements:

1. The Inspection & Test plan will highlight the Engineer and/or Owner hold, or witness points specified herein and to inspect the progress, materials and procedures at any time during the fabrication and assembly of the Biosolids Drying System and associated equipment.

   a. Notify the Engineer and Owner of the test schedule not less than fifteen (15) days in advance.
   b. Travel expenses for the purpose of inspection and witness shall be to the account of the Engineer or Owner.

2. Supplier's Test Representative shall prepare a test report and certify any test results.

   a. Supplier shall obtain acceptance of test reports from the Engineer or Owner prior to shipment of equipment.

3.2 SYSTEM FACTORY TESTS

A. Perform Supplier's standard functional tests on the System including:

1. Connect equipment comprising functional components of the system as possible.
2. Perform functional tests on all equipment or components to verify proper operation and response to controls with equipment empty and unheated.

3.3 CONTROL PANEL FACTORY TESTS

A. The Supplier shall perform required testing on the Control Panel(s) to be furnished.

B. Perform manufacturer's standard and the following functional tests on the Biosolids Drying System Control Panel as follows:

1. Gather and furnish test information necessary to show conformance to specified requirements.
2. Test panel(s) for proper construction, electrical connection, and function.
3. Check all alarms, shutdown conditions, and automatic sequences to verify proper function.
4. Simulate interlocks and signals from other connected equipment in order to demonstrate specified Human Machine Interface functions and controls.

3.4 INSTALLATION

A. Install equipment in conformance with the Supplier's written instructions, with supervision and inspection performed by Supplier's representative.

1. Supplier and Contractor shall attend a Pre-Installation Meeting prior to beginning installation of the System.
2. Supplier shall visit site as needed to supervise and approve of installation of the System components. Minimum Supplier Installation services are 3 days onsite total, over 2 separate trips.

B. Equipment anchoring and mounting shall be in accordance with Supplier's requirements for the load criteria.

3.5 FIELD TESTS

A. The timing and scheduling for testing shall be coordinated with and be dependent upon the Owner's schedule and quality and quantity of sludge available for testing.

B. Component Test (Site)

1. Prior to startup, all equipment described herein shall be inspected for proper installation, connections, alignment, quiet operation, and satisfactory performance of all components by means of a component test conducted by the Supplier's representative, assisted by the installing Contractor and the Engineer. Minimum Supplier Component Test services are 2 days onsite total, over 1 trip.
2. Equipment testing shall be conducted after the complete installation of the System and all appurtenances, except as approved and accepted by the Owner or the Owner's representative.
3. Proposed test procedures shall be developed by the Supplier and submitted to the Engineer for review, comment, and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
4. A qualified representative of the Supplier shall supervise each test, analyze data, and certify the System performance during the test.
5. The Supplier shall provide a completed and signed Certificate of Proper Installation Form.
6. The Supplier shall successfully complete functional testing prior to performance testing.

C. Pre-Performance Test (Startup/Commissioning):

1. A Supplier's representative, assisted by the installing Contractor, Owners Operator and the Engineer, shall conduct testing to demonstrate continuous, reliable operation, not performance, while drying the sludge as specified herein. Minimum Supplier Pre-Performance Test services are with two people, 10 days onsite total, over 2 separate trips.
2. The Pre-Performance Test shall include operation of the System for a period of 2 business days without unplanned shutdown(s) due to equipment-, controls- or other system failures.
3. Stoppages due to any failure of Supplier's equipment, instrumentation and controls shall not exceed 30 minutes, and such stoppages shall not number more than three over the 2-day period. A greater number of stoppages or a stoppage longer than 30 minutes shall be deemed a failure of the Pre-Performance Test, and the test will terminate.

    a. Stoppages caused by others (Contractor, Engineer or the Owner) may occur without causing failure of the test. The Engineer or the Owner may elect to accept the results of the test including the stoppage or retain the Supplier at added cost to repeat the test to the account of the Engineer or the Owner.

4. Proposed Pre-Performance-Test procedures shall be developed by the Supplier and submitted to the Engineer for approval. Testing shall not begin until the test procedures have been approved by the Engineer.
5. A qualified representative of the Supplier shall supervise each test, analyze data, and certify the system operation during the test.

D. Performance Test:

1. During Performance Test, the Supplier shall take any readings or measurements, written or electronic, and collect any required samples for analysis in order to make the following determinations plus any other requirements listed in Performance Requirements in this Section:

   a. Sludge Feed Rate (lbs/hr, calculated based on feed pump speed)
   b. Sludge Feed Concentration (%wt., dry solids fed to the dryer)
   c. Dried Biosolids Concentration (%wt., dry solids discharged from the dryer)
   d. Dried Biosolids Temperature (°F, discharged from the cooling conveyor)
   e. Water Evaporation Rate (lbs water evaporated/hr)
   f. Natural Gas Consumption (therms (HHV), meter readings provided by Owner)
   g. Specific Energy Consumption (Btu/lb water evaporated)
   h. Meet or exceed 40CFR Part 503 requirements for Class A dried biosolids.

2. Samples shall be collected at intervals not exceeding 2 hours.
3. Performance determinations or requirements will be based on the arithmetic average of the test results obtained during the test period. The Supplier reserves the right to exclude obviously high, low or erroneous test results. As specified below, laboratory testing will be performed by the Engineer and/or the Owner.

   a. Analyses shall be based on the laboratory standard methods.
   b. Analyses for solids concentration shall be provided within 24 hours of submittal by the Supplier.

4. The Supplier shall prepare a formal Performance Test Report including all laboratory analysis reports, all measured flows, any mass and energy balance calculations, log sheets, photographs, calibrations, model numbers of test equipment and any other pertinent information to document the required Performance Requirement listed in this Section. Any suggestions for further optimization of the entire process unit will be listed for owners' action if desired.
5. The cost of all laboratory tests necessary to confirm the sludge characteristics for the initial Performance Test on the System will be to the account of the Engineer and/or Owner. All laboratory tests for the Performance Test shall be in conformance with the applicable portions of standard methods.

   a. If any test is terminated due to any failure of Supplier's equipment, instrumentation and controls and re-testing is required, the cost of all necessary laboratory tests shall be to the account of the Supplier.

6. The Minimum Supplier Performance Test services are 3 days onsite total, over 1 trip.

E. Process Training:

1. A Supplier's representative shall conduct training onsite to Operations, Maintenance, and other personnel. Goals from training include typical and aberrant operations, troubleshooting, maintenance operations, work procedures etc. Both

classroom setting and hands on training types. Supplier shall prepare training documents and agenda a minimum of 2 weeks prior to scheduled training. Minimum Supplier Training services are 4 days onsite total, over 1 trip.

3.6 OWNER ACCEPTANCE

A. In addition to the documentation associated with the completion of the Acceptance Testing, the Manufacturer shall provide the Owner with documentation that states the installation of the indirect biosolids drying system has been inspected, meets the manufacturer's guaranteed requirements, and is free from faults and defects. Once this documentation is received and training is complete, the Owner will issue a written letter of acceptance.

3.7 PERFORMANCE GUARANTEE AND WARRANTY

A. The Indirect Biosolids Drying System Manufacturer (supplier) shall provide a performance guarantee that states the following:

1. The indirect biosolids drying system Manufacturer hereby unconditionally and irrevocably guarantees to the Owner, the performance and operating parameters described in these specifications and as submitted in the Manufacturers's proposal.
2. The indirect biosolids drying system Manufacturer agrees the system performance shall be based on field measurements from instrumentation as monitored by the Owner. The Owner agrees to immediately notify the indirect biosolids drying system Manufacturer if the guaranteed performance and operating parameters are not met.

B. Manufacturers shall provide a 1-year warranty for all system components from the date of successful startup and Owner acceptance unless otherwise noted.

3.8 SPARE PARTS

A. Recommended spare parts shall be furnished by the manufacturer.

END OF SECTION

SECTION 44 44 13 – CHEMICAL FEED EQUIPMENT

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. This project includes chemical metering systems designed for storage and pumping of Poly Aluminum Chloride (PAC), and Soda Ash (Na2CO3). This section also includes requirements for an NClear chemical batching and pumping system for chemical feed to sludge digesters 1 and 2.

B. All components shall be resistant to corrosion from contact with this chemical.

1. Descriptions of the chemical system
2. Chemical feed pumps/skids
3. Bulk storage tanks
4. Batching tank with mixer
5. Combination bag loading hopper and dust collector
6. Chemical piping

1.3 SUBMITTALS

A. Submit product data including, but not limited to, furnished specialties, size, accessories, details of construction, dimensions of individual components, profiles, finishes, descriptions of all materials, complete bill of materials, description of surface preparation, shop priming, and finish painting.

B. The Contractor, equipment manufacturer(s) and/or supplier(s), and representative(s) shall be responsible for reviewing the specified equipment during the bid period, and confirming that the specified equipment and appurtenances are suitable for use in this application, and, for notifying the Engineer immediately upon discovery of any issues with the use of the equipment in this application.

C. Shop Drawings Showing:

1. Complete dimensional data.
2. Mounting details.
3. Equipment locations.
4. Chemical system layouts

D. Product Test Reports: Based on evaluation of tests performed by the manufacturer and witnessed by a qualified independent professional engineer, indicate compliance of equipment for applicable codes, based on comprehensive testing within the last two years of current products.

E. Maintenance Data: Include name, address, and telephone number of manufacturer's nearest authorized service representative.

F. Comply with all safety regulations for equipment and chemicals used in these applications.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each chemical system component as a complete unit from one source and by a single supplier. The chemical system supplier shall provide all equipment, instrumentation, and controls as described in the drawings and specifications.

B. Pumps to be the manufacturer's standard product. Manufacturers of tubing pumps must have at least 100 operating installations in domestic water or wastewater treatment plants located in the United States for at least seven years pumping the same fluid as specified.

C. The metering skids shall be a regularly marketed product of the manufacturer which must have a physical plant, technical and design staff, and production personnel located in the USA to complete the work as specified. Systems assembled by second party fabricators, integrators, contractors, or manufacturers not normally engaged in chemical metering system design and manufacturing shall not be acceptable.

D. The manufacturer shall supply a minimum of five separate references with contact names and phone numbers, where substantially similar installations for the equipment as specified have been in satisfactory operation for a minimum of two years.

E. The manufacturer shall have a proven track record of after-market sales and service support on its equipment.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store equipment in a manner to avoid significant or permanent damage.

1. In general, comply with the manufacturer's written instructions for the storage of equipment.
2. The equipment shall be stored in a clean, dry location free from construction dust, precipitation, and excess moisture.

1.6 WARRANTY

A. Warranty Period: *Five (5) years* from the date of Substantial Completion.

1. The warranty shall be for unlimited usage of the equipment for the specified rated capacity over the term of the warranty.
2. The system supplier shall have sole responsibility for all components required for each of the chemical feed systems provided, PAC and NaOH.

1.7 SPARE PARTS

A. Contractor shall provide the following spare parts to the Owner for each chemical metering skid upon delivery of the pump skid. Spare parts shall include all parts

required for (2) years of normal maintenance of all components of the chemical metering system. All parts shall be in one box labeled with the Skid ID Information:

1. 2 - Replacement pump heads for each model of pump
2. P/M kit for each pressure relief valve.
3. Spare valve of each size for each pump skid.
4. Parts list for all serviceable components.
5. One complete set of any special tools required to dismantle pump(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The chemical metering systems shall be completely self-contained and designed to safely feed metered amounts of all chemicals as described herein. Each chemical metering skid shall include chemical metering pumps, piping, controls, and accessories described herein and shown in the drawings.

B. Metering Pumps and Pump Skids

1. Watson-Marlow 530 series
2. Verder
3. Grundfos
4. Flomotion

C. Bulk Storage Tanks and Accessories

1. PolyProcessing
2. Assmann

D. NClear Batching System

1. Merrick
   a. Bag loading hopper/dust collector
   b. Batching tank with mixer

2.2 DESCRIPTIONS OF SYSTEMS

A. The PAC and Na2CO3 Systems shall include the following components.

1. The supplier shall provide Two (2) storage tanks, one for each system. The tanks shall include seismic restraints, instrumentation, nozzles and pipe connections pipe rack, wiring, piping, valves, fittings, insulation, heaters and appurtenances as specified herein. The tanks shall be located as shown on the drawings
2. One (2) pump skid for each system. The skid shall include duty and standby peristaltic pumps, wiring, piping, valves, fittings, and appurtenances as specified herein. The skid shall be located as shown on the drawings.
3. The PAC and Na2CO3 systems shall be located in the Digester Blower/Chemical Building and the NClear pump skid shall be located at the existing UV/Filter Building.

B. NClear System

1. One (1) batch tank with mixer
2. One (1) bag loading hopper with integral dust collector
3. One (1) pump skid

2.3 METERING PUMPS

A. Pumps shall suitable for 24 hr/day outdoor operation at the following flow parameters:

CHEMICAL	PAC	Na2CO3	N-Clear
No. Pumps	2	2	2
Min. Feed Rate – USGPH	0.0006	0.0006	0.0006
Max. Feed Rate - USGPH	55	55	55

B. Pumps shall be positive displacement peristaltic type complete with spring-loaded pump head, self-contained variable speed drive, and flexible extruded tube as specified.

C. Peristaltic pumping action is created by the compression of the flexible tube between the pump head rollers and track, induced forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum-creating restitution of the tube.

D. Pumps shall be dry self-priming, capable of being run dry without damaging effects to pump or tube, and shall have a maximum suction lift capability of up to 30' vertical water column. Pressure rating: 50 psi.

E. Pump shall not require the use of check valves or diaphragms and shall not require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components.

F. Flow shall be in the direction of the rotor rotation, which can be reversed and shall be proportional to rotor speed.

G. Pump head shall consist of a fixed track, a hinged guard door, two spring-loaded tube clamp mechanisms, and a spring-loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees and be held in place on the suction and discharge by a spring-loaded self-adjusting clamp mechanism. At all times, one roller shall be fully engaged with the tubing providing complete compression and preventing backflow or siphoning. Tube occlusion and spring tension shall be factory set to accommodate 2.4mm wall thickness tubing and shall not require adjustment for accommodating tubing of 1.6mm to 9.6mm ID.

H. Pump head guard shall be transparent for the purpose of viewing direction of rotation. When closed, the pump head guard shall seal against the pump track for leak containment and control waste through the pump head waste port in the event of a tube failure. For operator and environmental safety, pumps in which the direction of rotation cannot be visually verified and/or do not have a controlled waste port are not acceptable.

1. Pump head Assembly

    a. Pump Track Geometry must have a minimum 96.6mm swept diameter through a minimum track angle of 180 degrees.
    b. Provide high corrosion/impact-resistant materials as specified.

        1) Track Construction: polyphenylene sulfide (PPS).
        2) Guard Construction: hinged impact-resistant polycarbonate breakaway guard, tool un-lockable for operator safety.
        3) Rotor Construction: polyphenylene sulfide (PPS).

    c. Tube Retainer Mechanism

        1) Provide two spring-loaded adjustable tube retainer m to secure the tubing at the entry and exit points of the pump head.

    d. Rotor Assembly

        1) Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:

            a) Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution.
            b) Compressing Rollers: 316SS with low friction stainless steel bearings and PTFE seals, minimum diameter of 18mm.
            c) Provide non-compressing guide rollers constructed of corrosion resistant Nylatron.

        2) Clutch: Equip the rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch shall automatically reengage rotor to gearbox upon one complete revolution.
        3) Mounting: To prevent slip, the rotor assembly shall be axially secured to the dogged output shaft of the gear motor via a slotted collet and central retaining screw.
        4) Pump heads requiring disassembly or special tools for tube changing are not acceptable.

I. Pump tubing shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by tube retainer clamps. The tubing shall be replaceable without the use of tools and with no disassembly of the pump head. To achieve maximum flow per revolution, pump heads with a track angle of less than 180 degrees are not acceptable.

J. Pump tubing shall be compatible with the chemical being pumped.

K. Tubing must be replaceable with the rotor in the stopped position. For operator safety, pumps that require the rotor to be rotating and/or requiring special pulling tools are not acceptable.

L. Supply a 15-meter roll of specified tubing size for each chemical feed system.

M. Pump Manual Interface and Control:

1. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.

    a. Display: Backlit graphical TFT Display capable of up to 8 lines of text with up to 26 characters per line to display flow rate and programming instructions. The display shall also provide a visual indication of running status via screen color: Grey = Running, White = Stopped, and Red = Warning.
    b. Keypad: Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.
    c. Flow units: Programmable in following units: µl/min, ml/min, ml/hr, l/min, l/hr, l/day, gallons/hr, gallons/day, g/min, kg/hr, or lb/day.
    d. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency start/stop.
    e. Auto Restart: feature to resume pump status in the event of power outage interruption.
    f. Multilingual menu: include programming menus in ten languages, including at a minimum English, Spanish, and French.
    g. Programmable “Maximum Speed” to allow the operator to set the maximum speed of the pump within 0.1-220 rpm

2. Supply auto control features to meet the following minimum functionality requirements. Pumps not meeting this minimum functionality will not be accepted.

    a. Remote Control Inputs

        1) Speed Control:

            a) Primary Analog 4-20mA or 0-10VDC speed input, with input signal trim able and speed scaleable over any part of the drive speed range.
            b) Provisions for alternative remote accessory potentiometer (if supplied by others)

    b. Start/Stop Control: via 5V TTL, 24V industrial logic, dry contact, or powered 120VAC contact as required per the process and instrumentation drawings- Configurable command sense allowing open to equal run or open to equal stopped.
    c. Forward/Reverse Control: via 5V TTL, 24V industrial logic, dry contact, or powered 120VAC contact as required per the process and instrumentation drawings.
    d. Auto/Man Mode Control: via 5V TTL, 24V industrial logic, dry contact, or powered 120VAC contact as required per the process and instrumentation drawings.
    e. Leak Detector Run/Stop Control

3. Discrete Status Outputs (via 120VAC-rated dry contacts)

    a. Running/Stopped status

b. Forward/Reverse status
c. Auto/Manual status
d. General Alarm status
e. Leak Detected status

4. Analog Status Outputs (via 4-20mA output signal from the pump)

a. Pump Speed

N. Pump Drive

1. Rating: Continuous 24 hour operation, 40°C ambient.
2. Supply: 110-120V 50/60 Hz and 220-240V 50/60 Hz, 1-Phase field switchable. Supply a nine-foot length mains power cord with a standard 115V three-prong plug.
3. Max drive power consumption: 135VA.
4. Enclosure: NEMA 4X.
5. Housing: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. By nature of the environmental conditions, unpainted housings, including 316SS, are not acceptable.
6. Drive motor- brushless DC motor with integral gearbox and tachometer feedback.

a. Speed Control Range of 2200:1 from 0.1 to 220 rpm +/- 0.1 rpm throughout the range.
b. Closed-loop microprocessor controlled drive with pulse width modulation at speeds above 35 rpm and synchronous mode with magnetic field rotation control below 35 rpm.
c. Circuitry complete with temperature and load compensation and protection.

7. Leak Detector: The pump manufacturer shall supply an optical leak sensor mounted to the drain port of the pump head for leak detection and pump shut down in the event of a tubing failure.
8. A Tubing Rupture Detector shall be provided to automatically shut down the pump and signal an alarm in the event of a tubing rupture within the pumphead. The detector shall consist of a sensor directly installed on the pumphead and a wall-mount controller/indicator. The detector shall have the following features:

a. No moving parts.
b. LED signals alarm condition.
c. 5 amp @ 250VAV DPDT latching relay
d. Single reset pushbutton
e. 110 VAC input.

9. Mounting: Drive shall be self-supporting and shall not require anchoring.

2.4 PUMP SKIDS

A. The chemical metering for skids shall be CNC Routed from HDPE sheet or Co-Polymer Polypropylene sheet stock with a minimum thickness of ½ inch. The design of the skid shall include gussets and supports as required for all components and shall be self-supporting. The skid shall be designed with a minimum of a 2-1/2" containment lip to contain spills. All components of the chemical metering system shall be contained

within the skid. The skid shall be manufactured using continuous welding technology; bolted construction is not acceptable. Pump stands with a minimum height of 3” shall be provided to elevate the metering pumps above the skid base.

B. The Nclear chemical feed skid system shall be housed in a 72-inch high by 72-inch wide by 72-inch deep FRP enclosure.

1. The enclosure shall have a flip-top cover and entrance door for access to the equipment.
2. The enclosure shall be designed for use in areas containing corrosive chemicals and high humidity.
3. The enclosure shall be Shelter Works or equal.
4. Heater:

    a. FRP enclosure shall be supplied with a 1500-watt, 120-volt single-phase slab heater.
    b. Heater shall be mounted and designed to prevent damage to the FRP enclosure while in operation.

2.5 PIPING DESCRIPTION

A. The pre-piped skid mounted system shall include (1) pressure relief valve(s); (1) diaphragm protected pressure gauge(s); (1) calibration column(s), and all required piping, isolation valves, and supports as required to serve (2) pumps shall be pre-piped on the skid. The pump(s) shall be piped to provide service to the main chemical feed point.

B. Piping shall include isolation valves and unions for all serviceable components. The chemical supply piping shall feature a calibration column designed for independent use with any of the metering pumps while other pumps remain in active service. The pump connections shall be designed with replaceable pipe sections on the suction and discharge via union or flange so that pump replacement or upgrade can be accomplished without cutting into skid piping. Provide flexible tubing connections and quick connects between fixed piping and suction and discharge of the pumps.

C. The piping shall be attached to the chemical metering skid with a non-metallic corrosion resistant support system. All support extensions shall be factory attached to the skid. The straps shall be removable and reusable to allow for servicing of the system. All inlet/outlet connections, valves, and pump accessories shall be clearly labeled on the skid for easy identification.

D. The chemical feed skid manufacturer shall be responsible for providing Nema 4x interface boxes with labeled terminal strips per pump for input and output control wires. The chemical feed skid manufacturer is also responsible for installing all control wiring from the pumps to the Nema 4x interface boxes. The electrical contractor is responsible for running the conduit into the Nema 4X interface boxes.

E. The chemical feed skid manufacturer shall be responsible for providing a prewired and piped 120V receptacle with weatherproof cover for each skid mounted pump completely independent from the control wiring. Each skid will have an electrical junction box that has been prewired from the 120V receptacle for the electrical contractor to tie into. The electrical contractor is responsible for running the conduit and

tying it into skid mounted electrical junction box and installing 120V supply power to the skid.

F. The chemical metering skids shall be completely assembled and tested by the manufacturer before delivery to the job site.

G. The design and fabrication of the chemical metering skids shall comply with the following criteria:

1. All piping shall be fabricated to production drawings that detail all pipe nipples, fittings, valves, metering accessories, supports, etc.
2. The manufacturer before delivery shall hydraulically and electrically test each system. Testing shall be documented and include verification of pump performance and response to remote systems using simulation equipment as required.

H. Accessories

1. Calibration Columns

a. A clear calibration column made of materials compatible with pumped fluid shall be provided in the chemical supply piping. The calibration column shall be direct reading in both ml/minute and Gallons/Hour and sized to allow at least a 30-second drawdown.

2. Pressure Relief Valves

a. Pressure relief valves shall be provided in the discharge piping of each metering pump, before any valves, to eliminate the buildup of excess pressure in the system. The pressure relief valves shall be fully adjustable from 10 – 150 psi with bodies compatible with the pumped fluid. The spring-loaded valve shall have a Teflon diaphragm and no metal parts in contact with the chemical. The outlet of the pressure relief valves shall be field piped to return to the day tanks.

3. Diaphragm Protected Pressure Gauges

a. Liquid filled pressure gauges with isolators shall be provided for indication of system pressure in the suction piping and the discharge piping of each metering pump. Industrial quality all 316 Stainless Steel gauges shall be utilized. The isolators shall have housings compatible with the pumped fluid. The isolation diaphragm shall be Teflon. The process connection shall feature a SS reinforcement ring, not in contact with the chemical. A fabricated PVC bracket shall be provided for each pressure gauge to secure the isolator and prevent lateral movement of the pressure gauge. The gauge face shall be 2-1/2" inches in diameter.

2.6 PIPING, FITTINGS AND VALVES

A. Polyvinylchloride (PVC)

1. Pipe and fittings shall be manufactured of Rigid Poly Vinyl Chloride (PVC) schedule 80. Fittings shall be heavy-duty Schedule 80 molded fittings.
2. All pipe and fittings shall bear the company's name or trademark, material designation, size, applicable IPS schedule, and the NSF mark as indicative of compliance with this specification.
3. All fittings shall be injection molded of PVC fitting compound of cell classification 12454-B and of CPVC fitting compound of cell classification 23447-B as described in ASTM D- 1784 Standard Specification for Rigid Poly Vinyl Chloride Compounds.
4. Workmanship shall be in accordance with good commercial practice. Fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. The fittings shall be commercially uniform in color, opacity, density, and other physical properties.
5. All molded threads, internal or external, shall be "blunt start" threads. All threads shall conform to thread standard ANSI/ASME B1 .20.1 for tapered pipe threads. Threads shall measure not more than 11/2 threads large or small when checked with a plug gauge or ring gauge.
6. Dimensions and tolerances of sockets shall conform to PVC IPS Schedule 80 Socket Dimensions. All reducer bushings shall be designed so as to provide for a positive and sufficient grip for cementing bushings in place.
7. Waterways shall be smooth and commercially free of flash and irregularities. On tees and 90° elbows, bond lines shall not coincide with the maximum stress area (crotch).
8. Assembly shall be performed in a controlled shop environment by the skid manufacturer. All pipe shall be squarely cut on precision equipment with the ends chamfered and deburred. All socket welded connections shall follow the guidelines set by the pipe/fitting manufacturer for proper cleaning, priming and gluing procedures. A heavy bodied solvent suitable for use with Soda Ash shall be used. All threaded connections will utilize Teflon tape, a suitable thread sealant, or a combination of both. Threaded connections shall utilize stainless steel reinforcement rings where applicable to reduce the risk of cracking.

B. Isolation Valves

1. Ball Valves

a. All Ball Valves, sizes 1/2" to 4", shall be of true union design with two-way blocking capability. All O-rings shall be EPDM or FPM based on the chemical being pumped. Seats shall have elastomeric backing cushion of the same material as the valve seals. Stem shall have double O-rings and be of blowout-proof design. The ball valves shall have a pressure rating of 230 psi for sizes"1/2" to 3" and 150 psi for 4" at 70 º F. Ball Valves must carry a two-year guarantee. Ball valves shall be equal to Hayward TB series as manufactured by Hayward Flow Control.

C. All exposed chemical feed piping shall be heat traced and insulated per specification section 26 44 00.

2.7 BULK STORAGE TANKS

A. Bulk Storage Tanks

1. The CONTRACTOR shall provide a vertical tank of high density cross-linked polyethylene. Tanks furnished under this Section shall be supplied by a manufacturer who has been regularly engaged in the design and manufacture of chemical storage tanks for over 10 years.
2. The tank shall have a minimum capacity of 10,000 gallons. The tank shall be designed for above-ground, vertical installation and shall be installed on the existing concrete foundation. The tank shall incorporate an integrally molded flanged outlet (IMFO) that is a homogenous flange system that is molded as part of the tank while it is being manufactured. Post-production inserts will not be accepted. The flange shall be located at the bottom of the tank to allow complete draining. The tank shall be capable of storing the required chemicals at atmospheric pressure and shall be designed for outdoor exposure.
3. Tanks shall be manufactured from virgin materials.
4. Tanks shall be rotationally-molded, vertical, high-density cross-linked polyethylene, one-piece seamless construction, cylindrical in cross-section and vertical with flat bottoms. Tanks shall be adequately vented. Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories. Tanks shall be marked to identify the manufacturer, date of manufacture and serial numbers must be permanently embossed into the tank.
5. Chemical storage tanks shall be suited for the following operating conditions:

    a. High-Density Cross-linked Polyethylene resin used in the tank manufacture shall be Poly CL™ or equal and shall contain ultraviolet stabilizer as recommended by the resin manufacturer. Where black tanks are indicated, the resin shall have a carbon black compounded into it. The tank material shall be rotationally molded and be a resin that is commercially available at the time of tank manufacture.
    b. For sodium hypochlorite, sulfuric acid storage, and other oxidizing chemicals, tank resin shall include an antioxidant polyethylene system (OR-1000) with four times the antioxidant properties of a standard polyethylene bonded to the interior surface during the manufacturing process.

6. Wall thickness for a given hoop stress is to be calculated per ASTM D 1998. In NO case shall the tank thickness be less than design requirements per ASTM D 1998.

    1. The wall thickness of any cylindrical portion at any fluid level shall be determined by the following equation:

$$T = P \times OD/2SD \quad \text{or} \quad 0.433 \times SG \times H \times OD/2SD$$

Where:	T	=	wall thickness, in
	P	=	pressure, psi
	SG	=	specific gravity, gm/cc
	H	=	fluid head, ft
	OD	=	outside diameter, ft
	SD	=	hydrostatic design stress

    a. The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support but shall not be less than 0.187” thick.

7. On closed top tanks the top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall be equal to the thickness of the top of the straight sidewall. In most cases, flat areas shall be provided for attachment of large fittings on the dome of the tank.
8. The bottom head shall be integrally molded with the cylindrical wall. Knuckle radius shall be:

Tank Diameter, ft	Min Knuckle Radius, in
less than or equal to 6	1
greater than 6	1-1/2

9. Tanks with 3000 gal capacity or larger shall have at least 3 lifting lugs. Lugs shall be designed for lifting the tank when empty.

    a. Unless otherwise indicated by Contract drawings, for indoor pneumatic fill, manways shall be 24-in diameter or greater and equipped with an emergency pressure relief device or SAFE-Surge™ Manway with pressure relief at 6" water column to prevent over-pressurization. The SAFE-Surge manway shall be chemically compatible with the chemical being stored. Gaskets shall be closed cell, cross-linked polyethylene foam, Viton, or EPDM materials.
    b. Unless otherwise indicated by Contract drawings, for outdoor pneumatic fill, manways shall be 24-in diameter or greater and equipped with Poly Processing Company's F.S.2650® combined manway and vent to prevent over pressurization of tank. Manway must be capable of relieving a volume flow rate of up to 2650 ACFM. Gaskets shall be closed cell, cross-linked polyethylene foam, Viton, or EPDM materials.
    c. Unless otherwise indicated, tanks less than 2000 gallons in non-pneumatic applications shall have a manway cover 17-in or smaller of Polyethylene material with a coarse thread. Gaskets shall be closed cell, cross-linked polyethylene foam, viton or EPDM materials.
    d. Tanks must be vented to allow for performance at atmospheric pressure.
    e. Tank colors shall be natural (unpigmented), black (compounded), or as specified by the ENGINEER with written agreement by the tank manufacturer.

10. Tank shall be insulated with polyurethane foam with a density of 2.5 lb/ft^3 with a minimum R-value of 6.3/in. The foam shall be applied with a nominal thickness of 2" to the external tank surfaces except the tank bottom. Upon completion of application and curing of the insulation, 2 full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such a manner as to seal the insulation from the outside environment.
11. A tank heating system shall be designed by the tank manufacturer and shall be factory installed prior to shipment.

    a. The system shall be complete with controller and heating pads shall have a 30°F delta-T.
    b. The controller shall have a NEMA 4X/IPP66 polycarbonate enclosure and shall be furnished with 4-20Ma outputs for remote monitoring.

c. The contractor shall furnish and install a 240V power source as shown on the electrical drawings.

12. A hydrostatic water test shall be conducted prior to shipment. The hydrostatic water test shall consist of filling the primary tank to brim-full capacity for a minimum of four hours and conducting a visual inspection for leaks. The assembly shall be designed to prevent rainwater and debris from entering the containment tank.
13. The tank shall be designed to provide a minimum of 4 tie-down lugs. The tie-down lugs shall be designed to allow tank retention in wind and seismic loading situations without tank damage. The tank shall be anchor bolted to an appropriate structure and not require additional spacer blocks.
14. The tank shall be furnished with fittings as specified herein. All flanged fittings shall be constructed of Schedule 80 PVC with a minimum of 4 fully threaded 316 S.S. studs. Each fitting shall have two EPDM gaskets and two flanges suitable for use with the chemicals contained. One gasket shall be compressed between the inside of the tank wall surface and the inside flange of the fitting. The other gasket shall be compressed between the outside tank wall surface and the outside flange of the fitting. Gaskets shall be a minimum of ¼" thickness. The tank(s) shall be furnished with the following fittings:
15. The tank(s) shall be furnished with the following fittings:

    a. Tank inlet: 3" bolted fitting
    b. Tank Vent: 6" bulkhead fitting
    c. Overflow: 2" bolted fitting
    d. DP, Level: 3" bolted fitting
    e. RTD: 1 1/2" bolted fitting
    f. Tank outlet: 2" IMFO flange bolted fitting
    g. Sight Glass: 1" bolted fitting
    h. Manway: 24" emergency relief
    i. Expansion joints shall be provided with fittings that are located in the lower one-third of the tank. Expansion joints must be rated for the chemical stored and have the following minimum requirements:
        1) Bolted fitting, 316SS, EPDM Gasket
        2) Axial compression ≥ 0.67"
        3) Axial extension ≥ 0.67"
        4) Lateral deflection ≥ 0.51"
        5) Angular Deflection ≥ 14°
        6) Torsional Rotation ≥ 4°

B. The tank(s) shall be furnished with OSHA-approved anchoring and tie-downs.

1. The tie-down system shall be designed to withstand 150 MPH wind loads. Tie-down systems must meet seismic requirements per IBC 2009 / CBC 2010 code with seismic loads ≤ .445g (Seismic Design Category "D" - Fa=1.0, Fv=1.5, Ss=1.4, S1=0.5). Anchor bolts shall be provided by the contractor per the calculations and the base plates for the system. A registered engineer's wet stamped calculations and or drawings may be required. The tie-down system shall be 316 stainless steel.

C. The tank(s) shall be furnished with a free-standing, pipe rack. The rack shall be constructed of 304 Stainless Steel 4" x ¼" square tubing and shall be anchored to the concrete floor. The rack shall accommodate the following components:

1. All piping to and from the top of the tank, including valves, fittings and appurtenances.

D. The tank shall be provided with a stainless steel access ladder at locations as shown. Safety cages shall be added to ladders as required, per OSHA.

1. The tank shall be provided with a stainless steel access ladder at locations as shown. Safety cages shall be added to ladders as required, per OSHA.
2. Ladders must be secured to the tank and secured to the concrete to allow for tank expansion/ contraction due to temperature and loading changes. Use proper chemical-resistant materials when anchoring to tank dome or sidewall.
3. All ladders shall be designed to meet applicable OSHA standards. Reference: OSHA 2206; 1910.27; fixed ladders.

E. Each tank must be vented for the material and flow and withdrawal rates expected. U-vents should comply with OSHA. The vents shall be sized by the tank manufacturer and be furnished complete with an insect screen.

F. Factory Testing

1. Dimensions: Take exterior dimensions with the tank empty, in the vertical position. Outside diameter tolerance, including out-of-roundness, shall be per ASTM D 1998. Fitting placement tolerance shall be +/- 1/2-in vertical and +/- 1-degree radial.
2. Visual: Inspect for foreign inclusions, air bubbles, pimples, crazing, cracking, and delamination.
3. Hydrostatic test: Following fabrication, the bottom tanks, including inlet and outlet fittings, shall be hydraulically tested with water by filling to the top sidewall for a minimum of 1 hour and inspected for leaks. Following successful testing, the tank shall be emptied and cleaned before shipment.

2.8 PAC SYSTEM CONTROLS

A. The PAC chemical feed system shall be monitored and controlled through the plant SCADA system.

B. The system integrator shall be responsible for SCADA programming of all functions and screens.

C. The system shall be controlled in the following modes of operation:

1. Automatic Dose Control: SCADA shall automatically adjust the feed pump speed in response to changes in plant flow rate so that the dose remains proportional to changes in plant flow rate. SCADA shall display the following variables at all times:

a. Current dosing rate in mg/L
b. Tank Level: display % of tank volume
c. Tank Temperature: display temperature in degrees Fahrenheit
d. Feed Pump status: color-coded (ON/OFF/FAIL)
e. Feed Pump speed feedback: % speed

2. Manual Dose Control: Feed pump speed shall be adjusted manually at the SCADA HMI. SCADA shall display the following variables at all times:

    a. Current dosing rate in mg/L
    b. Tank Level: display % of tank volume
    c. Tank Temperature: display temperature in degrees Fahrenheit
    d. Feed Pump status: color-coded (ON/OFF/FAIL)
    e. Feed Pump speed feedback: % speed

3. Local Dose Control: Feed pump speed shall be adjusted at the pump skid. SCADA shall display the following variables at all times:

    a. Current dosing rate in mg/L
    b. Tank Level: display % of tank volume
    c. Tank Temperature: display temperature in degrees Fahrenheit
    d. Feed Pump status: color-coded (ON/OFF/FAIL)
    e. Feed Pump speed feedback: % speed

4. The SCADA system shall display and record the following system alarms:

    a. Tank level Low (order chemical).
    b. Tank level Low.
    c. Tank level High (activates alarm beacon and horn to prevent overfilling).
    d. Tank temperature low.
    e. Tank leak.
    f. Feed pump fail.
    g. Feed pump tube rupture.

5. The following safety interlocks and permissives shall be programmedfor the PAC system:

    a. Feed Pump start permissive:
        1) Tank level is not low.
        2) Tank temperature is not low.
        3) Tube rupture alarm is not activated.

6. All displayed variables shall be logged every 30 minutes during normal operation of the system. The data shall be exportable into a CSV file.

7. The operator shall be able to change control mode and/or setpoint on the control panel touch screen at all times.

8. Instrumentation

    a. The Tank Level Sensor shall be differential pressure style, flange mounted.
    b. The Tank Temperature sensor shall be an RTD.

2.9 Na2CO3 SYSTEM CONTROLS

A. The Na2CO3 chemical feed system shall be monitored and controlled through the plant SCADA system.

B. The system integrator shall be responsible for SCADA programming of all functions and screens.

C. The system shall be controlled in the following modes of operation:

1. Manual Dose Control: Feed pump speed shall be adjusted manually at the SCADA HMI. SCADA shall display the following variables at all times:

    a. Current dosing rate in mg/L
    b. Tank Level: display % of tank volume
    c. Tank Temperature: display temperature in degrees Fahrenheit
    d. Feed Pump status: color-coded (ON/OFF/FAIL)
    e. Feed Pump speed feedback: % speed

2. Local Dose Control: Feed pump speed shall be adjusted at the pump skid. SCADA shall display the following variables at all times:

    a. Current dosing rate in mg/L
    b. Tank Level: display % of tank volume
    c. Tank Temperature: display temperature in degrees Fahrenheit
    d. Feed Pump status: color-coded (ON/OFF/FAIL)
    e. Feed Pump speed feedback: % speed

3. The SCADA system shall display and record the following system alarms:

    a. Tank level Low (order chemical).
    b. Tank level Low.
    c. Tank level High (activates alarm beacon and horn to prevent overfilling).
    d. Tank temperature low.
    e. Tank leak.
    f. Feed pump fail.
    g. Feed pump tube rupture.

4. The following safety interlocks and permissives shall be programmedfor the PAC system:

    a. Feed Pump start permissive:
        1) Tank level is not low.
        2) Tank temperature is not low.
        3) Tube rupture alarm is not activated.

5. All displayed variables shall be logged every 30 minutes during normal operation of the system. The data shall be exportable into a CSV file.

6. The operator shall be able to change control mode and/or setpoint on the control panel touch screen at all times.

7. Instrumentation
    a. The Tank Level Sensor shall be differential pressure style, flange mounted.
    b. The Tank Temperature sensor shall be an RTD.

2.10 NClear SYSTEM CONTROLS

PART 3 - EXECUTION

3.1 GENERAL

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting the performance of equipment.

B. General: Comply with manufacturer's detailed written instructions for installing equipment.

C. Testing and Adjustment:

1. Following the completion of each chemical feed system, the systems and equipment shall be operated and tested for conformance to the specifications.
2. Adjust pumps, piping, valves and appurtenances per manufacturer’s recommendations.
3. Tanks and piping shall be tested for leakage according to the requirements in this specification.

3.2 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition.

B. Provide final protection and maintain conditions, in a manner acceptable to the manufacturer, and ensure that equipment is without damage or deterioration at the time of Substantial Completion.

3.3 START-UP ASSISTANCE AND TRAINING

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train the Owner's maintenance personnel as specified below:

1. A factory authorized service representative (for each system and/or piece of equipment) from the manufacturer shall perform all necessary on-site assistance and installation supervision for each chemical system.
2. A factory authorized service representative shall provide a minimum of one eight (8) hour day of startup services for each system.
3. Once the chemical systems have been installed correctly and are operating as intended, the service representative(s) shall perform sixteen (16) hours of on-site start-up assistance/operator training.
4. Train the Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventive maintenance.
5. Schedule training with the Owner with at least seven days advance notice.

B. Before startup and testing of the chemical feed equipment The contractor shall furnish the following chemicals;

1. Fill the polyaluminum chloride (PAC) and Soda Ash (Na2CO3) bulk storage tanks.
2. Provide one (1) tote of polymer for the Screw Press polymer feed skid.
3. The Contractor shall use the plants chemical suppliers for sourcing of chemicals. See contact informations below.

a. Soda Ash (Na2CO3)- Industrial Chemicals, INC
   Diane Kalina, dianekalina@industrialchem.com, 678-234-3916
b. Poly aluminum chloride (PAC) and Polymer– Cedarchem
   Tyler Hess, tyler.hess@cedarchem.com, 404-784-5352
c. Nclear – Nclear Environmental Technologies
   Mathew Velker, mvelker@nclear.us, 777-605-3171

END OF SECTION 44 44 13

SECTION 44 44 16 – ULTRAVIOLET DISINFECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract drawings, specifications and pre selected equipment proposal in the appendices and general provisions of the Request for Proposal (RFP) apply to this section.

B. Section 26 29 00 Manufactured System Control Panels.

1.2 SUMMARY

A. The UV Disinfection system has been pre-selected by the Owner through a request for proposals solicited to dewatering system Manufacturers. The specifications that follow were the basis for manufacturers to develop proposals and the pre-selected manufacturer's proposal can be found in **Appendix E** of these specifications.

B. The Work of this section includes a complete UV Disinfection system and all associated components. The section shall serve as a detailed description of the scope of supply for the services of UV Disinfection system suppliers.

C. The UV Disinfection system shall be provided complete with all accessories and appurtenances, and be the end product of one responsible system manufacturer or system supplier. The supplier shall furnish and/or coordinate all components and accessories as necessary to place the equipment in operation in conformance with the specified performance, features and functions indicated herein.

D. An installing Contractor shall be responsible for furnishing and installing the system as specified herein.

1.3 GENERAL REQUIREMENTS

The Work of this section includes the design, fabrication, testing, delivery, and onsite services for a complete ultraviolet disinfection (UV) system.

A. UV Manufacturer's scope of supply shall include but not be limited to:

1. Narrative describing the complete scope of supply
2. UV modules
3. Lamps
4. Quartz sleeves
5. Lamp to ballast cables
6. Ballasts
7. Automatic lifting device
8. UV intensity monitoring
9. UV Transmittance monitoring
10. Automatic wiping system

11. Low water level sensor
12. Ultrasonic level sensor
13. Automatic level control device
14. Spare parts

B. The system shall be capable of disinfecting effluent to meet the water quality standards listed in this section.

C. Review of the equipment data by the Engineer shall not relieve the Contractor or the manufacturer of responsibility for all detailed dimensions and correct fitting of all parts, or for the satisfactory operation and service of the equipment as specified.

1.4 SUBMITTALS

A. **Certification from Contractor and Manufacturer/Suppliers:** During the bid period and again prior to submitting/ordering and installing materials, products and equipment, the Contractor and all manufacturers and suppliers shall thoroughly review the materials, products and equipment being supplied and shall familiarize themselves with the existing and proposed/new facilities, as well as connections to existing facilities/utilities. This shall include field verification of the location, nature, size/dimensions, current and intended future use, etc. Prior to ordering and installation, the Contractor shall coordinate with all manufacturers and suppliers to provide all needed information including field dimensions, photographs, information on related materials and equipment, etc.). The Contractor and all manufacturers and suppliers shall include written confirmation (with the submittal) of the following:

1. The materials, products, and equipment being supplied are of the correct size, materials and type.
2. The materials, products and equipment being supplied do not conflict with existing or proposed/new facilities.
3. The products/equipment being supplied are intended for use in this application.
4. All manufacturer(s) and supplier(s) shall provide (either with submittals or separately) written concurrence/acknowledgement of their review/coordination and concurrence with the items above.
5. Shop drawings and product data submitted for review by the Engineer shall bear the Contractor's certification that he has reviewed, checked, and approved the submittals, that they comply with the requirements of the project and with the provisions of the Contract Documents, and that he has verified all sizes, dimensions, locations, field measurements, construction criteria, materials, catalog numbers, and similar data. Field dimensions, sizes and other pertinent information shall be clearly shown on the shop drawings/submittals. The Contractor shall also certify that the work represented by the shop drawings is recommended by the Contractor and that the Contractor's warranty and guaranty shall fully apply.

B. Complete bill of materials listing all items to be supplied.

C. Product Data: Include performance data, furnished specialties, cut sheets and ancillary equipment data.

D. Shop Drawings: Show dimensioned equipment layout and electrical connections.

Include setting drawings with templates, conduit locations, directions for installing anchor bolts, and other anchorages.

E. Hydraulic calculations demonstrating compliance with the required hydraulic characteristics.

F. Manufacturers a third-party bioassay validation certificate submitted with the project bid documents. The full bioassay report shall be made available to the Engineer for review upon request. Only bioassays that are conducted by an independent third party shall be accepted, without exception. Bioassay validation methodology shall follow protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003).

G. Electrical schematics and layouts and description of operation of system controls.

H. Complete manufacturers specifications.

I. Provide basis of design including background data, calculations, test reports, operational data and other information showing the design development per this specification.

J. Provide an unexecuted copy of the required Warranty Bond.

K. Provide startup and performance testing report and manufacturer's certification required in section 3.

L. Testing procedures, requirements and results specified in section 3.

M. Provide Operational and Maintenance Data manuals.

N. Executed Proposal Agreement.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect UV system against damage.

C. Comply with UV manufacturer's rigging instructions for handling.

1.5 QUALITY ASSURANCE

A. To be considered, the manufacturer shall be regularly engaged in the manufacture of UV systems with a proven track record.

B. The manufacturer shall provide documentation of previous experience with municipal UV disinfection systems in wastewater applications with variable output electronic ballasts.

C. The manufacturer shall provide the services of a UV Manufacturer representative to supervise and inspect and certify the equipment is operating as designed. The manufacturer shall provide classroom and field training on the operation and maintenance required at each installation. The manufacturer shall provide a representative to supervise the performance testing. Representatives' days on-site shall be 8 hours per day not including travel time. Additional days on-site if requested by the owner shall be negotiated between the Owner and the UV Manufacturer. See Table 1 for requirements.

Table 1 – Manufacturers Representative Requirements

Task	Duration
Pre-installation Meetings and Site Visits	1 day (minimum)
Installation Supervision	2 days
Startup and Functional Testing	7 days
Performance Testing	3 days
Operator Training	1 day (minimum)

D. Submittals from manufacturers shall include a complete and detailed proposal of equipment offered, including the number of lamps, modules, ballasts, and ancillary equipment.

E. Manufacturers shall include a detailed description of any exceptions taken to the specification.

F. The manufacturer shall submit a bioassay evaluation for the proposed reactor, without exception. The bioassay shall have been completed by an independent third party and have followed protocols described in the latest edition of the UVDGM Ultraviolet Disinfection Guidance Manual. The bioassay must demonstrate that the proposed UV system design and number of lamps shall deliver the specified dose using MS2 bacteriophage as the surrogate test organism.

G. Independent certification of fouling factor and lamp aging factor must be submitted if values other than the specified default values are being proposed.

H. Documentation of UV manufacturer's service capabilities including location and experience.

I. Sample disinfection performance guarantee including scope and duration of the guarantee.

1.6 WARRANTY

A. The equipment furnished under this section shall be free from defects in materials and workmanship, including damages that may be incurred during shipping, storage and installation for a period of 1 year from date of startup.

B. The UV Manufacturer shall provide the Owner with a warranty bond equal to the UV equipment contract as a guarantee that the installed system produces a final effluent which meets the bacteriological inactivation requirements and is within the specified

power consumption, ballast and lamp life requirements. The filtered effluent quality entering the UV system shall be equal to or better that specified above when measuring performance. The bond shall be for a term of 1 year from the date of written acceptance of the UV system by the Engineer and Owner. The term of the bond shall be extended to match any extended warranty term submitted by the Manufacturer.

C. Warranty shall be for unlimited usage of the equipment for the specified rated capacity over the term of the warranty.

D. The UV lamps shall be warranted for a minimum of 14,000 hours of operation prorated after 9,000 hours. The manufacturer shall warrant that the UV lamp output will be no less than the EOLL factor (with fouled sleeves) listed in this specification.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Trojan Technologies – Trojan UVSigna

2.2 DESIGN, CONSTRUCTION AND MATERIALS

A. Design Criteria: The equipment furnished shall be low-pressure, high-output ultraviolet light disinfection equipment designed to reduce E. coli micro-organisms of treated wastewater so that the final effluent shall meet the discharge conditions specified herein. The UV systems shall be hydraulically rated for the peak hourly flow rates listed and shall provide a minimum dose of 50,000 microwatt-sec/cm^2 (50 mJ/cm^2) validated by independent third-party bioassay as outlined by NWRI, at the peak flow rates listed in Table 1 below.

1. The UV system shall be configured as follows:

a.	Number of Channels:	2
b.	Number of Banks per Channel:	3(2 Duty, 1 Redundant)
c.	Lamps per Bank:	16
d.	Total Number of Lamps:	96
e.	Number of System Control Centers:	1
f.	Number of UV Sensors:	1 per bank
g.	Number of Power Distribution Centers:	2
h.	Number of Level Controllers:	2

B. Design Criteria Provide a UV disinfection system complete with UV Banks and lifting mechanism, System Control Center, Power Distribution Centers, and Water Level Controller(s) as shown on the contract drawings and as herein specified.

C. The ultraviolet disinfection system will produce an effluent conforming to the following discharge permit: 23 Fecal Coliform/100 ml, based on a 30 day Geometric Mean. .Grab samples will be taken in accordance with the Microbiology Sampling Techniques found in *Standard Methods for the Examination of Water and Wastewater, 21st Ed*.

D. The UV system will be designed to deliver a minimum RED of 50 mJ/cm^2 at peak flow, in effluent with a UV Transmission of 65% at end of lamp life (EOLL) after reductions for quartz sleeve fouling. The basis for evaluating the RED will be the independent third party bioassay, without exception. Bioassay validation methodology to follow applicable protocols described in NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (May 2003, 2012) and 2006 USEPA UVDGM.

E. The RED will be adjusted using an end of lamp life factor of 0.5 to compensate for lamp output reduction over the time period corresponding to the manufacturer's lamp warranty. The use of a higher lamp aging factor will be considered only upon review and approval of independent third party verified data that has been collected and analysed in accordance with protocols described in the NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (May 2003, 2012).

F. The RED will be adjusted using a quartz sleeve fouling factor of 0.8 to compensate for quartz sleeve transmission reduction due to wastewater effluent fouling. The use of a higher quartz sleeve fouling factor will be considered only upon review and approval of independently verified data that has been collected and analysed in accordance with protocols described in the NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (May 2003, 2012). The data recorded for the determination of the validated fouling factor must be obtained by testing in secondary wastewater effluent utilizing the same lamp, quartz sleeve and cleaning system proposed by the UV manufacturer.

G. The UV systems shall be installed in the new open concrete channels. The system manufacturer shall confirm the channel dimensions are adequate for their system to meet the requirements in Table 2 below.

Table 2 – UV Design Criteria

No. Channels	2
Average Design Flow	6 MGD
Peak Design Flow	12 MGD
Total Suspended Solids	10 mg/L(maximum)
Allowable effluent temperature	41-86° F
Ultraviolet Transmittance @ 253.7 nm	65%, minimum
Fecal Coliform (30-day geometric mean)	23 col/100mL
UV Dose	50 mJ/cm^2

H. The UV systems shall The system design shall be based on independent third-party bioassay test results, with the following criteria. The basis for evaluating the UV dose delivered by the UV system shall be by an independent third-party bioassay, without exception. Bioassay validation methodology shall follow protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003). The dose shall be evaluated on the basis of MS2 bacteriophage only.

I. The system shall be designed for outdoor installation. The ballast cabinets and control panel will be installed in the Filter/UV Control Building.

J. General:

1. Materials of Construction:

    a. All module metal components, including anchoring hardware, in contact with effluent shall be Type 316 stainless steel.
    b. All metal components above the effluent, including anchoring hardware, shall be Type Type 316 stainless steel.
    c. All wiring exposed to UV light shall be Teflon™ coated.
    d. All wires connecting the lamps to the ballasts shall be enclosed inside the frame of the UV Module and not exposed to the effluent.

K. UV Bank:

1. Each UV bank will consist of UV lamps, quartz sleeves and an automatic chemical/mechanical cleaning system mounted in a Type 316 stainless steel frame.
2. Each lamp will be enclosed in its individual quartz sleeve, one end of which will be closed and the other end sealed by a lamp end seal. To be considered as an alternate, lamp quartz sleeves that are open at both ends will be supplied with twice the amount of specified spare seals and lamps.
3. The closed end of the quartz sleeve will be held in place by a retaining O-ring. The quartz sleeve will not come in contact with any steel in the frame.
4. Each UV bank will contain a pre-formed Type 316 stainless steel wall on each side to prevent possible short-circuiting at the side walls of the reactor.
5. Each UV bank will contain light locks at the top of the bank to prevent short circuiting over the top of the lamps and maximize disinfection efficiency.
6. Each UV bank will be rated Type 6P. UV banks that are not Type 6P rated are not acceptable.
7. To minimize maintenance, equipment must be provided by the UV manufacturer to enable lifting a complete bank of lamps from the channel at once for inspection and/or servicing.

L. UV Lamps:

1. Lamps will be high intensity low pressure amalgam design. Lamps that are not amalgam will not be allowed.
2. The filament shall be significantly rugged to withstand shock and vibration.
3. Electrical connections for the lamp will consist of four (4) pins at one end of the lamp only. Lamp wiring shall be Teflon insulated stranded wire.
4. Lamps without maintenance coating or that do not have four (4) pins are considered instant-start and are not acceptable due to reduced reliability and increased maintenance and operating costs.
5. Lamps will be rated to produce zero levels of ozone.
6. The lamp shall withstand an average of four (4) on/off cycles per day without reducing lamp life, warranty or causing any damage to the lamp.
7. Lamps will be operated by electronic lamp drivers with variable output capabilities ranging from 30% to 100% of nominal power. The lamp assembly shall incorporate active filament heating to maintain a minimum lamp efficiency of 35% across varying water temperatures and between the minimum and maximum stated lamp power levels.

M. Lamp Plugs:

1. Each lamp plug will be accessible from the top of the UV bank to facilitate lamp removal without moving the UV banks or any other components.
2. Each lamp plug shall have provisions for a light emitting diode (LED) visual indicator that indicates on/off status for each lamp.
3. An integral safety interlock in the lamp plug will prevent removal of energized lamps.
4. The lamp plug shall be rated Type 6P.

N. Lamp Drivers:

1. Each lamp driver will independently power two (2) UV lamps. Failure of one lamp will not affect operation of the other lamp.
2. The lamp driver will have a power factor correction circuit to ensure minimum 99% power factor and less than 5% total harmonic distortion (THD) current at the maximum power level and nominal input voltage.
3. The lamp driver electrical efficiency will be minimum 95% at the maximum power level.
4. The lamp driver will be programmed-start type utilizing filament preheat followed by a high voltage pulse to ignite the lamp.
5. During lamp operation, variable filament heating current shall be provided according to a predetermined curve to maintain optimum filament temperature and amalgam temperature to ensure maximum lamp life and maintain a minimum lamp efficiency of 35% across varying water temperatures and between the minimum and maximum stated lamp power levels.
6. A ground fault in the output circuit shall be detected and communicated as a warning to the external controls system while the corresponding lamp operates undisturbed.
7. The communication protocol shall be Modbus implemented on an RS485 electrical interface.
8. Local visual diagnostic will be provided with LEDs for lamp driver status, lamp status (on, idle, preheat, fault), power and communication status.
9. For reliability and to facilitate trouble shooting, at a minimum, the following external indicators (protections, status, warnings and alarms) shall be provided: lamp status, driver status, ground fault, and communication time-out.
10. The lamp driver shall be UL, CE, and RoHS compliant.

O. Quartz Sleeves:

1. Quartz sleeves will be clear fused quartz circular tubing containing 99.9% silicon dioxide.
2. Sleeves will have minimum UV transmittance at 254nm of 87% (2.5mm wall thickness).
3. Sleeves will be open at one end only and domed at the other end.

P. Cleaning System:

1. An automatic in-situ cleaning system will be provided to clean the quartz sleeves using both chemical and mechanical methods. Wiping sequence will be automatically initiated with capability for manual override.

2. The cleaning system shall also incorporate an integrated debris removal device to clear the quartz sleeves of any large solids or debris to maximize the life of the chemical/mechanical cleaning system.
3. The wiper on the cleaning system shall be parked out of the effluent when not in use.
4. Cleaning systems that utilize a screw drive, or park the wiper in the effluent while not in use shall not be acceptable due to collection of debris in and around the wetted parts of the wiper.
5. The cleaning system will be fully operational while UV lamps and modules are submerged in the effluent channel and energized.
6. To minimize maintenance, UV System will be designed such that cleaning solution replacement can be performed while the UV Bank and lamps are in place and operational in the channel.
7. Cleaning sequence frequency will be field adjustable to enable optimization with effluent characteristics.
8. Cleaning system operation will be remote auto (default) or remote manual.
9. The cleaning system will be provided with the required solutions necessary for initial equipment testing and for equipment start-up.
10. The wipers shall travel the full length of the UV lamp arc. Designs in which the wipers only travel part way along the sleeves will not be acceptable.
11. The UV intensity sensor shall be cleaned utilizing the same chemical/mechanical cleaning method as that of the lamp quartz sleeves. UV intensity sensors that only utilize a mechanical means shall not be acceptable.

Q. Effluent Level Controller:

1. Modulating Weir Gate

a. Modulating Weir Gates (MWGs) shall be self-contained and shall be designed and manufactured by an experienced and reputable manufacturer, based on the AWWA C561 Standard for Fabricated Stainless Steel Slide Gates and AWWA C542 Standard for Electric Motor Actuators for Valves and Slide Gates in effect as of the date of this specification.
b. Modulating weir gates will be designed to maintain the minimum channel effluent level required to keep lamps submerged at all times
c. MWGs shall be designed for the following performance criteria:

1) MWG actuation speeds shall be between 10” (255 mm) and 14” (356 mm) per minute.
2) MWG maximum design rate of change of flow shall be limited to 25% of the Peak Design Flow/Channel per minute, or alternatively, flow shall be ramped up (zero to peak) or down (peak to zero) in no less than 4 minutes.
3) MWG actuators shall employ AWWA S4-50% duty class motors with a rated minimum 900 starts per hour capability.
4) MWG actuators shall employ AWWA Class B solid-state Thyristor based switchgear capable of at least 5,000,000 modulating steps before overhaul; electromechanical type actuators and controls shall not be permitted.

R. Light Locks:

1. Light locks, two (2) per bank, will be provided to force effluent through the UV treatment zone maximizing disinfection performance.
2. The entire length of the lamp arc will remain submerged to maximize UV dose delivered to the effluent and to prevent any UV exposure above the water free surface.

S. Electrical:

1. All applicable electrical components will be UL-listed to ensure safety standards are met.
2. Each UV lamp within a bank will be powered from a Power Distribution Center.
3. UV Manufacturer to supply all cabling between lamps and drivers.
4. Each electronic lamp driver will power two lamps.
5. Power factor will not be less than 99% leading or lagging.
6. Electrical supply to each Power Distribution Center will be 480/277V 60Hz, 53.5 kVA.
7. Electrical supply to the Hydraulic System Center will be 480V 60Hz, 2.5 kVA
8. Electrical supply to the low water level sensor box will be from 120V, 1 Phase, 2 Wire + GND.
9. Electrical supply to the System Control Center will be 120V 60Hz, 1.8 kVA
10. The UV System electrical panels are not provided with electrical disconnects. Each electrical power supply should be provided with a separate disconnect to be supplied by the Contractor.

T. Power Distribution Center (PDC):

1. The configuration of Power Distribution Centers shall be lamps per PDC.
2. PDC enclosure material will be 304 Stainless Steel.
3. All internal components will be sealed from the environment.
4. All Power Distribution Centers to be UL-approved or equivalent.
5. An internal heater will be provided in the PDC to prevent condensation when the external temperature drops below the dew point.
6. Each PDC shall be able to electrically isolate each bank of lamp drivers and safely replace a lamp driver without de-energizing any other operating banks.

U. Hydraulic System Center:

1. The Hydraulic System Center (HSC) houses the components required to operate the automatic cleaning system and bank Automatic Raising Mechanism (ARM).
2. HSC enclosure material will be 304 Stainless Steel (Type 4X, IP 66) (Type 4X).
3. The HSC will contain hydraulic power unit complete with pump, fluid reservoir, manifolds, valves

V. Control and Instrumentation:

1. Refer to electrical plans for additional control & instrumentation requirements.
2. System Control Center (SCC):

    a. Refer to Specification Section 26 29 00 (“Manufactured Control Panels”) for additional panel requirements.

b. The monitoring, operation and control of the TrojanUVSigna is managed at the System Control Center (SCC) by a CompactLogix with a SCC HMI Beijer -12" (Outdoor 4X Rated) HMI screen. This PLC shall be provided with a network connection to the plant SCADA system for all system monitoring and control functions. Refer to Specification Section 26 29 00 (“Manufactured Control Panels”) for network connection requirements.

c. If the SCC is installed outdoors, the operator interface shall be positioned out of or away from direct sunlight and shall include a sunshade. The operator interface screen will be designed for a rugged outdoor environment capable of operating at ambient temperatures between -30 Deg C and +70 Deg C with a high brightness display (minimum 1000 Nit). HMI screen shall be certified for outdoor use (UL50E Type 4X Outdoor).

d. Alarms will be provided to indicate to plant operators that maintenance attention is required or to indicate an extreme alarm condition in which the disinfection performance may be jeopardized. The alarms will include, but not be limited to:

    1) Individual Lamp Failure
    2) Multiple Lamp Failure
    3) Low UV Intensity
    4) Bank Communication Alarm
    5) The 100 most recent alarms will be recorded in an alarm history register and will be displayed when prompted.
    6) Mode of operation for UV Banks can be manual, automatic or remote.
    7) Elapsed time of each bank will be recorded and displayed on the display screen when prompted.

e. Low Water Level Sensor:

    1) The UV Manufacturer will provide one (1) low water level sensor for each UV channel.
    2) During all modes of system operation (manual, automatic and remote), the water level sensor will ensure that lamps extinguish automatically if the water level in the channel drops below an acceptable level.

f. UV Intensity Sensors:

    1) A UV sensor will continuously monitor the UV intensity produced within each UV Bank.
    2) The sensors will measure only the germicidal portion of light emitted by the lamps.
    3) The UV sensor shall be factory-calibrated to US National Institute for Standards and Technology (NIST). Sensors requiring field-calibration are not acceptable.
    4) The sensor shall be digitally calibrated to ensure calibration accuracy.
    5) To ensure continuous disinfection, the sensor shall be accessible without shutting down the system, lifting a bank/module or removing lamps.
    6) Sensors will be designed to provide UV intensity data for dose monitoring and control functions. Dose pacing program will enable use of measured UV intensity along with flow rate and UVT to determine

the delivered dose during operation.

7) Sensors will be designed such that reference sensor readings can be taken without interrupting disinfection and without removing UV lamps, banks/modules or sleeves.

g. Dose-Pacing:

1) A dose-pacing system will be supplied to modulate the lamp UV output in relationship to an Ethernet-based UV system flow signal/parameter and UV intensity sensor(s).
2) The system to be dose-paced such that as the flow and effluent quality change, the design UV dose is delivered while conserving power.
3) The dose-pacing system will allow the operator to vary the design dose setting. Logic and time delays will be provided to regulate UV Bank ON/OFF cycling.

W. UV Bank Lifting Device:

1. The lifting device for UV Banks will be supplied by the UV Manufacturer.
2. An Automatic Raising Mechanism (ARM) will be designed and supplied to facilitate lifting a UV bank from the channel without use of ancillary equipment.
3. The ARM will be integrated into the UV Bank for simple and seamless operation.
4. The UV Bank will be raised from the channel for easier access and maintenance.
5. The ARM design will provide access to components without having to break electrical connections thus reducing wear on connectors.

X. Spare Parts:

1. The following spare parts and safety equipment to be supplied.
   a. A number of spare lamps equal to 10% of the total number of lamps supplied.
   b. A number of spare quartz sleeves equal to 10% of the total number of quartz sleeves supplied.
   c. A number of spare ballasts equal to 5% of the number of ballasts supplied
   d. A number of spare quartz seals equal to 10% of the total number of quartz seals supplied.
   e. A number of spare wiper rings equal to 10% of the total number of wiper rings supplied.
   f. Operators kit including face shield, gloves and cleaning solution.
   g. To be considered as an alternate, systems that require more lamps than specified, the UV manufacturer shall provide spares in the amount equal to the quantities listed plus an additional quantity equal to the percentage of lamps required over and above the number of lamps specified.

PART 3 - EXECUTION

3.1 INSTALLATION AND OPERATION

A. Pre-Installation Meetings and Site Visits:

1. The UV Manufacturer's representative, Contractor, and Engineer shall attend a pre-installation meeting prior to the construction of the concrete UV channels. The

Manufacturer shall discuss general procedures, dimensions, tolerances, installation instructions and sequence, and any other relevant topics required. The meeting may be held on-site or virtually via video conference.

2. After the construction of the concrete channels, the UV Manufacturer's representative shall examine areas and conditions, with the Contractor and Engineer, for compliance with the tolerances required for proper installation and performance of the equipment. If the concrete channels are in compliance with the requirements, the UV Manufacturer shall provide written certification to the Contractor and Engineer that the channels have been properly constructed and are ready for the equipment to be installed. If the channels are found to be out of compliance with the requirements the Contractor shall be responsible for correcting all deficiencies to bring the concrete channels into compliance. The Contractor shall bear any costs associated with the Manufacturer's representative to return to the site and verify compliance.

B. The UV Manufacturer shall verify that all equipment is in suitable condition and ready for installation.

C. Installation of the equipment shall be in accordance with instructions and recommendations of the Manufacturer.

D. The UV Manufacturer shall provide support to the Contractor during the equipment installation, and shall provide startup and commissioning services as required to verify that components are free from damage and are properly fitted, assembled, installed, and ready for operation.

E. The UV Manufacturer shall provide startup and commissioning services as required.

3.2 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition or replace with new.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure equipment is without damage or deterioration at the time of Substantial Completion.

3.3 TESTING REQUIREMENTS

A. Install the UV disinfection system in strict compliance with the UV Manufacturer's instructions and recommendations.

B. Functional Testing

1. Prior to startup, the UV Manufacturer's representative shall inspect the installed UV disinfection system for proper alignment, correct operation, proper connection, and satisfactory function of all components. The UV manufacturer's representative shall approve the installation and provide certification that the system components have been installed correctly and are ready for operation.
2. Proposed functional testing procedures shall be developed by the UV Manufacturer, submitted to the Engineer, and approved by the Engineer not less than two weeks prior to scheduling and performing the functional test.

3. Functional testing shall include proof of the fiber optic Ethernet interface between the UV controller and the plant control system. All functions be monitored and controlled by the plant's SCADA system shall be tested to ensure correct functionality prior to final acceptance of the UV system.
4. If, in the opinion of the Engineer, the system meets the requirements specified herein, the system shall advance to the performance testing.
5. If, in the opinion of the Engineer, the functional tests do not meet the requirements specified herein, performance testing shall not begin until the UV Manufacturer has made, at no cost to the Owner, such adjustments, changes, and /or additions as necessary to correct the system and demonstrated this by a satisfactory functional test as specified above.

D. Performance Testing

1. The UV manufacturer shall submit the proposed performance testing procedures for the Engineer's review and approval not less than two weeks before scheduling and executing the performance test. The performance test shall include effluent quality test, preliminary lamp output test, and power consumption tests.
2. The guaranteed effluent quality shall only be considered to be achieved when both performance testing demonstrates that the system meets the performance requirements of this specification within the power consumption range predicted by the UV Manufacturer.
3. Effluent Quality Test

    a. The UV Manufacturer shall conduct one effluent quality test. The purpose of the effluent quality test is to confirm that the system is capable of producing the stated final effluent quality under the specified worst-case design conditions (i.e., peak flow, minimum UV dose, the lowest UV transmittance, and the highest suspended solids), and power consumption does not exceed the system peak power consumption specified.
    b. If, during the test period, the UV influent conditions are significantly better than the worst-case design conditions, the effluent quality test shall be conducted under actual plant flow conditions.
    c. The effluent quality test shall be carried out as soon as the functional test of all individual equipment is completed satisfactorily. The duration of the test program shall be 3 days. If the UV system is forced to shut down during the test, then the 3-day test shall be repeated until it is satisfactorily passed.
    d. Prior to the start of the effluent quality test, the UV Manufacturer shall propose the number, location, and power outlet of online UV lamps based on the measured filtered UV transmittance and average lamp age and the average UV dose to be delivered. The lamps shall be cleaned at the frequency recommended by the UV Manufacturer and approved by the Engineer, UV dosage shall be calculated based on a clean lamp.
    e. The timing for the test shall be determined based on the diurnal flow variations and the laboratory working hours.
    f. On each day during the effluent quality tests; 10 sets of grab samples from the UV influent and 10 sets of grab samples from the effluent of the UV disinfection facility shall be collected and analyzed for E.-coli levels. At the time these samples are collected, the following information shall be recorded:

        i. Date and Time

ii. UV intensity
iii. Lamp Age
iv. UV transmittance reading from UVT monitor
v. Power output levels
vi. Effluent flow rates

In addition to being analyzed for E.-coli levels, the UV influent samples shall also be analyzed for the following:

i. UV transmittance (filtered and unfiltered)
ii. Total suspended solids
iii. $CBOD_5$

g. The effluent quality test shall be considered to be successful if testing performed under actual worst-case design conditions demonstrates all of the following:
h. The geometric mean of the final effluent E.-coli levels of the 30 samples is less than 23 col/100m. Power consumption does not exceed system peak power consumption as specified.

4. Lamp Output Testing

a. The UV Manufacturer shall submit the proposed lamp output testing procedures to the Engineer for approval not less than two weeks before scheduling and executing the testing.
b. The UV Manufacturer shall conduct testing of 15 percent of the total in-service UV lamps at 100 hours of operating time.
c. Lamp Output shall be tested at room temperature in darkroom using a calibrated International Light model 1700 radiometer to rest the irradiance of the lamp at a 3-meter distance. The lamp shall be tested vertically with the irradiance readings taken at its center.

5. Power Consumption & Harmonic Testing

a. Guaranteed performance requirements for power consumption shall be measured. The power consumption per lamp including ballast losses is calculated to be the total power draw divided by the number of lamps powered.
b. Measurement shall be taken when all lamps in all modules in the channel are ON and set to full power. Kilowatt-hours and power factor shall be measured and recorded. Measurements shall be made using a kilowatt-hour meter temporarily mounted at the location stated. The meter manufacturer shall have calibrated the meter within the 6 months immediately preceding the test.

i. Power consumption testing shall be conducted within 1 month of startup of the system at a time when all components are functioning satisfactorily.
ii. If, for any reason, additional lamps are required after installation in order to meet performance requirements, the power consumption guarantee based on the initial number of lamps shall remain in effect.

c. The power testing apparatus shall be provided by the Contractor. Testing shall be conducted under supervision by a vendor technician.

d. The harmonic current and voltage attributable to the UV disinfection system as measured in the power distribution system shall be measured for all bank configurations prior to final acceptance. The point of common coupling is defined as the line-side terminals of the isolation transformer feeding the system. If the measured harmonic current and voltage do not comply with Tables 10.2 and 10.3 of IEEE 519-1992, then the UV Manufacturer shall make modifications to limit the harmonic distortion through their equipment.

3.4 SUPERVISION, CERTIFICATION, AND REPORT OF TESTING

A. The UV Manufacturer's representative shall supervise the functional testing, effluent quality testing, lamp output testing, and power consumption testing, analyze data and certify the system's performance during the test. Tests shall be documented during the continuous operation of the system, and the UV Manufacturer shall submit to the Engineer three copies of a complete report containing all data, calculations, lab report sheets, and a description of all of the testing procedures and results.

3.5 ACCEPTANCE/NONACCEPTANCEOF SYSTEM

A. If, in the opinion of the Engineer, the system meets the performance requirements during the performance testing specified herein, and the Owner has received the executed Warranty Bond, the Engineer shall recommend to the Owner, by letter, the official acceptance/approval of the UV disinfection system. If in the opinion of the Engineer, the test results do not meet the performance requirements during the performance testing, the Engineer shall notify the UV manufacturer and the Owner in writing of the non-acceptable performance.

B. In the case of non-acceptable performance, the UV Manufacturer shall then have 30 days in which to perform, at the UV Manufacturer's sole expense, any supplemental testing, equipment adjustment, changes, or additions and request and perform an additional retest of the non-acceptable system.

C. Should the UV system fail to meet the requirements of the Specifications or the performance requirements after three attempts, the UV Manufacturer shall remove the system and replace it with one that shall meet the performance requirements.

3.6 MANUFACTURERS CERTIFICATION

A. Submit a letter from the UV Manufacture stating that he/she has inspected the installation and checked its performance and certifies that the installation is operating correctly and meets all the requirements of this section and references sited herein.

3.7 WARRANTY BOND DELIVERY

A. Following installation, startup, testing and satisfactory completion of performance testing, delivery of all required parts, chemicals, documents and other items required in this specification, submit the executed warranty bond to the Owner.

END OF SECTION 44 44 16

SECTION 44 46 26 – SPIRAL BLADE CLARIFIER

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall furnish and install the equipment for two (2) circular spiral scraper cage drive clarifiers, including all equipment and appurtenances required or shown on the drawings.

B. This section includes the following clarifier equipment:

1. Center Drive Unit and Torque Control
2. Walkway And Platform With Handrail
3. Stationary Center Influent Column
4. Energy Dissipating Inlet (EDI)
5. Center Feedwell
6. Rotating Drive Cage
7. Rake Arms With Spiral Blades
8. Sludge Withdrawal Ring/Manifold
9. Anchor Bolts
10. Scum Skimmer and Scum Box
11. Effluent Weirs
12. Scum Baffles
13. Density Current (Stamford) Baffles
14. Local Control Panels

1.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:

1. WesTec
2. Walker Process
3. Ovivo

It is the intention of this specification to cover minimum acceptable quality for a complete installation with the exception of the motor controls, electrical work and piping requirements. Part numbers or trade names are used in this specification only to facilitate the general configuration and description of the equipment desired and in no way imply that equal equipment of other manufacturers cannot be used. Products and specific variations of clarifier equipment from each of the manufacturers will be considered.

B. Contractor and Supplier Responsibilities

1. The design and layout of the clarifier equipment are based primarily on the WesTech spiral blade clarifier equipment.
2. It shall be the responsibility of each manufacturer/supplier to submit for approval (during the bid period) differences and/or exceptions for their equipment, and it shall be the responsibility of the Contractor to coordinate and to account for those differences in their sealed bid. No additional compensation will be paid by the Owner.

1.3 DESIGN REQUIREMENTS

A. Design Criteria (based on three clarifiers in service/operation)

Design influent flow rates per clarifier (w/o RAS)	
Avg. Design Flow Per Clarifier:	3 MGD
Maximum Daily Flow Per Clarifier:	6 MGD
Peak Hourly Flow Per Clarifier:	8 MGD
Design RAS flow rate:	6 MGD
MLSS:	5,000 mg/l
SVI:	150 ml/g
Weir diameter:	105 feet
Tank diameter:	105 feet
Sidewall depth:	18 feet
Side water depth:	16.5 feet
Freeboard:	1.5 feet
Bottom slope (confirm/coordinate w/Contractor):	0.65 inches/foot
Influent column outside diameter:	42 inches
Motor HP:	1 HP
Torque	
Design running:	45,500 ft-lbs.
Momentary peak:	91,000 ft-lbs.

B. All fabricated structural steel shall conform to the requirements of "Standard Specifications for Steel for Bridges and Buildings", ASTM Designation A-36.

C. All shop welding shall conform to the latest standards of the American Welding Society.

D. For the drive unit, all gearing in the drive train shall be AGMA rated for both strength and durability, and the minimum value used as the controlling limit. The following AGMA standard shall be used for the basis of design: 210.02 standard for surface durability; 220.02 standard for strength rating, and 440.03 standard practice for worm reducer.

E. The drive unit's main output gear shall have an AGMA rating that is be based on a life of $1x10^6$ cycles for both strength and durability. The companion pinion of the main output gear shall be based on a life $1x10^7$ cycles for both strength and durability criteria. The allowable stress for the AGMA strength rating of the main output gear and companion pinion shall not exceed that as designated by symbol S_{at} in the AGMA standards.

F. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall have a minimum thickness of 1/4 inch.

G. Stainless steel anchor bolts, with hex nuts, and washers, shall be provided for all parts of the clarifiers mechanism to be secured to the tank.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated

B. Shop Drawings: Include the following.

1. Certified general arrangement drawings showing all important details and materials of construction, dimensions, loads on supporting structures, and anchor bolt locations.
2. Complete catalog information, descriptive literature, materials of construction, wheels, gears, and bearing, trolley drive system, brakes, stating system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
3. Detail each equipment assembly, include make, model weight, and indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
4. Complete data on motors and speed reducers. Motor nameplate data shall be in accordance with NEMA MG 1 and include any motor modifications.
5. Wiring diagrams (including terminals and numbers) and electrical schematics for all control equipment to be furnished.
6. Calculations documenting the AGMA rating of the drive unit and life of the main bearing; prepared and signed by a registered professional engineer.
7. Complete descriptive information and electrical schematic for the torque overload device.Complete sludge transport calculations substantiating the rake blade design, rake tip speed, and floor slope.
8. Complete process calculations substantiating the sizing of the center column and ports, EDI and outlets, and outer feedwell. These calculations shall be based on parameters from the Manufacturer's operating experience. These parameters shall be verified by data presented from successful operating installations. Side-by-side comparison testing of EDI and feedwell design from existing operating clarifiers that have spiral rake blades and are products of the Manufacturer shall be presented with the calculations.
9. Calculations showing withdrawal rates and headlosses of the sludge withdrawal ring.
10. The submittal shall include data from other installations for performance verification of influent flow rate (Q), hydraulic loading (OFR), effluent suspended solids (ESS), return sludge solids concentration (RSS), return activated sludge flow rate (RAS) for secondary clarifiers, and waste sludge flow rate (WAS).
11. Factory finish system.

1.5 SHOP ASSEMBLY AND INSPECTION

A. The equipment specified herein shall be factory assembled as far as practical to verify that all mating parts can be field assembled. All mating parts shall be trial fit and match marked. The Manufacturer shall submit certification of shop trial assembly and photographs of assembly before shipment. The customer and Contractor shall be given the opportunity to witness the shop assembly.

B. Shop inspection shall be performed by a qualified inspector and certified by the Manufacturer. The inspection shall be documented, and all deficiencies noted, corrected, re-inspected and final completion formally authorized. Final shipment authorization shall be by the Manufacturer to ensure completion of all fabrication, assembly, and inspection requirements. Inspection records and evidence of inspector qualification shall be submitted to the Owner upon request.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, grooves, and weld ends.
3. Ship fabricated assemblies in the largest sections permitted by carrier regulations.

B. Use the following precautions during storage:

1. Store equipment indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store equipment off the ground in watertight enclosures.

C. Use sling to handle large pieces of equipment; rig sling to avoid damage to exposed parts. Do not use external equipment parts as lifting or rigging points.

1.7 WARRANTY

A. Warranty Period: One year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Description: The clarifier mechanism shall be of the center drive type, supported on a stationary influent column, with the flow entering at the bottom of the influent column and flowing upward into the energy-dissipating inlet. The flow shall then proceed into the feedwell through gates arranged for impinged flow near the water level for further energy dissipation and settling. The clarifier shall be designed to remove settled sludge from the bottom of the tank and floating scum from around the periphery of the tank. The clarifier shall perform the following integrated functions:

1. Dissipate energy and control localized currents.
2. Separate solids from the clear liquid.
3. Evenly withdraw the clear liquid.
4. Transport and thicken settled sludge.
5. Prevent sludge dilution at withdrawal point.
6. Remove scum from the clarifier surface.

B. Materials: All structural steel shall conform to AISC – Steel Construction Manual latest edition. All steel plates shall conform to ASTM A36. All structural steel shape series of M, MT, S, ST, C, MC, and L shall conform to ASTM A36. Structural steel shapes W, WT, HP shall conform to ASTM A992/A572. All pipe shall be ASTM A53, Grade B. All square and rectangular tubing shall be ASTM A500, Grade B, unless otherwise noted. Steel members in contact with liquids, either continuously or intermittently, shall have a minimum thickness of 1/4 inch unless otherwise noted. All aluminum shall be type 5052, 6061, 6063, or 2014 alloy unless noted. All stainless steel shall be type 316/316L unless noted.

C. Fabrication: Shop fabrication and welding of structural members shall be in accordance with the latest edition of the "Structural Welding Code", AWS D1.1, (AWS D1.2-Aluminum, AWS D1.6-Stainless Steel), of the American Welding Society. All welded connections shall develop the full strength of the connected elements, and all joined, or lapped surfaces shall be completely seal welded with a minimum 3/16" fillet weld. Intermittent welding shall not be allowed except on non-ferrous metals.

D. Edge Grinding: Sharp projections of cut or sheared edges of ferrous metals shall be ground to a radius by multiple passes of a power grinder as required to ensure satisfactory coating adhesion.

E. Shop Surface Preparation/Coating: All iron and steel surfaces, except the drive unit, shall be field cleaned and painted by the Contractor to ensure paint compatibility and assign unit responsibility for the coating system. The drive unit shall be coated with the supplier's standard enamel paint system.

F. Structural Design: All steel design shall be in accordance with the AISC Manual of Steel Construction, latest edition and the International Building Code (IBC), latest edition.

2.2 DRIVE UNIT

A. Design Parameters: The drive unit shall be designed and manufactured by the clarifier equipment supplier to ensure unit responsibility. The drive unit shall be designed for the torque values previously listed. It shall turn the mechanism at the design collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L 10 life of 50 years or 438,000 hours. The drive unit shall be capable of producing and withstanding the previously listed momentary peak torque while starting. The drive main gear shall be designed to a minimum AGMA 6 rating when rated in accordance with the latest AGMA standard. Gear teeth shall be designed for proper load distribution and sharing. Stub tooth design and surface hardening of the main gear shall not be allowed. The main bearing shall be capable of withstanding the listed overturning moment without the aid of any underwater guides or bearings to ensure correct tooth contact for AGMA rating of the main gear.

1. All spur gearing shall be designed to the latest AGMA spur gear standard for strength and surface durability, based on a life of 175,000 hours. The design running torque rating of the drive gearing shall be based on the smaller of the strength and durability values determined from the above AGMA standard. To ensure safety and ease of maintenance, all components of the drive shall be direct coupled.
2. No overhung pinions shall be allowed on the speed-reducing unit. The lower pinion bearing shall not be located below the turntable base.
3. Any and all welding on the drive unit shall be done using E70XX weld rod.

B. Physical Characteristics: The drive unit shall consist of a solid internal main spur gear, bearing turntable, pinion, secondary speed reducer, support base, and drive unit bearing. The drive shall be mounted on the center column and support the entire rotating load of the mechanism. The main internal gear shall be forged of alloy-hardened steel. The pinion shall be heat-treated alloy steel. Support base for the drive shall be of welded steel to assure rigidity. Dust shields shall be provided. The drive bearing shall include a forged steel precision gear/bearing set, with fully contoured raceways hardened to a minimum 58 62 Rc and protected by a neoprene seal. The drive shall be designed so that the balls and nylon spacers can be replaced without removing the access walkway. The main gear to pinion gear mesh shall be oil lubricated. An oil sight glass, fill pipe, and drain shall be provided for the reservoir. Lubrication fittings shall be readily accessible.

C. Overload Protection: An overload device shall be provided in a stainless steel, weatherproof enclosure. The device shall be actuated by torque generated from the main drive, which shall operate two independently adjustable switches (the alarm

switch at 100 percent of design running torque and the motor cutout switch at 120 percent of design running torque). Devices that require the worm to float and measure the thrust of the worm gear shall not be acceptable. These two switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque indicator shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 160 percent of design running torque.

D. Turntable: The turntable base shall have an annular bearing raceway upon which the rotating assembly rests. It shall have a maximum allowable deflection in accordance with the bearing specifications. The allowable modulus of elasticity shall be a minimum of 29 x 106 psi. The center cage shall be fastened to and supported from the gear casing. Ball bearings shall be of high carbon chrome alloy 52100 steel running in fully contoured races, as part of a precision gear/bearing set. The balls shall be grease lubricated and protected by elastomer seals. Felt seals that allow the entrance of moisture from outside the drive (i.e. rainwater, condensate, etc.) will not be allowed.

E. Speed Reducing Unit: The speed-reducing unit shall consist of cycloidal, helical, or planetary speed reducers directly connected to a motor without the use of chains or v belts and shall be keyed to the pinion.

1. The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high-speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The lobes of the cycloid disc shall engage successively with pins in the fixed ring gear. The movement of the cycloid discs shall be transmitted then by pins to the low-speed shaft. Speed reducer efficiency shall be a minimum of 90% per reduction stage.
2. Speed reducer helical or planetary gearing shall be manufactured to AGMA standards and shall provide at least 95% power transmission efficiency per stage. The speed reducer shall have a minimum service factor of 1.25 based on the output torque rating of the drive.
3. The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and be grease lubricated. As a safety feature, the speed reducer shall be back driveable to release any stored energy as the result of an over-torque condition.

F. Motor: The motor shall be a squirrel cage, induction type, TEFC, ball bearing heavy duty unit of ample power for starting and operating the mechanism without overload, with a minimum service factor of 1.15.

1. Power supply to the equipment shall be 240/480-volt, 60 hertz, 3 phase.

2.3 WALKWAY AND PLATFORM

A. Walkway: One (1) 36-inch-wide walkway and platform with handrails shall be supported by the drive unit and influent column at the center and the tank wall at its outer end and shall be designed to safely withstand a live load of 50 pounds per square foot. Deflection shall not exceed L/360 when both the dead load and live loads are applied. It shall consist of two trusses or beams with 1 1/4-inch aluminum I-bar grating between the trusses or beams. The walkway shall be diagonally braced against lateral movement, and provided with handrails 42 inches high, of double row 1 1/2-inch diameter horizontal aluminum pipe, and 4-inch-high kickplates on both sides. Walkway trusses may serve as the handrail if the top chord is 3 feet-6 inches above the walking

surface.

1. Stainless steel bearing plates, UHMW-PE slide plates, and anchor bolts for the wall support shall be provided by the equipment supplier and installed by the Contractor. Bearing plate dimensions and anchor bolt diameter, length, quantity, and arrangement shall be per the equipment supplier. The Contractor shall block out or otherwise modify the tank or support structure to accommodate walkway and supports, if required.

B. Center Drive Platform: A center drive platform shall be provided which allows 24 inches' clearance outside the center drive components. It shall consist of 1/4-inch aluminum checkered plate with necessary stiffeners and supports, resting on the drive unit and center column, and provided with connections to the walkway. The entire platform shall be surrounded by handrails 42 inches high of double row 1 1/2-inch diameter horizontal aluminum pipe with 4-inch high kickplates.

C. Furnish and install a 2” stainless steel (or copper) re-use/plant water pipe with wide angle bronze spray nozzles (at approximate 4’ centers) for controlling foam/scum on the surface of the clarifiers. Re-use/plant water pipe shall be insulated. A meter box with isolation valve and tee/drain valve shall also be provide adjacent to each clarifier to enable piping to be drained/isolated during cold weather or for maintenance.

2.4 INFLUENT AND SLUDGE REMOVAL

A. Stationary Center Influent Column: A stationary cylindrical steel influent column of 1/4" minimum wall thickness shall be provided. One end shall have a support flange for bolting to the tank floor over the influent line, with a similar flange at the top for supporting the drive unit and walkway. The structure and anchor bolts shall provide adequate support for the entire mechanism dead load plus live loads and torque with an adequate factor of safety to eliminate excessive deflection or vibration. Suitable openings shall be provided in the upper portion of the column to allow unrestricted passage of the flow into the energy-dissipating inlet. Prior to the center column being grouted in place, the drive unit shall be installed, positioned, and leveled.

B. Dual Gate Energy Dissipating Inlet (DG-EDI): A dual gate rotating circular energy dissipating inlet with bottom shall be supported by the cage and be designed to diffuse the liquid into the feedwell in an impinged flow direction without excessive disturbance or formation of vertical velocity currents. The DG-EDI shall be designed to positively prevent sludge from depositing within the DG-EDI and shall include bottom drain holes.

1. The diameter, depth, and detention time of the DG-EDI shall be included in the submittal with the design calculations and shall show proper process application as evidenced by the required successful operating installations.
2. The rotating DG-EDI shall be designed with a full bottom extending to within 1 inch of the center column. It shall include an upper rim angle for stiffness. Multiple discharge ports shall be provided to induce impinged flow. The gates shall have a fixed bottom to prevent vertical currents as the flow exits the DG-EDI.
3. The DG-EDI shall be made of not less than 3/16-inch-thick steel plate with necessary stiffening angles.
4. EDI Test Data – The submittal shall include data from side-by-side tests on identical full-scale operating clarifiers at least 100 ft. in diameter, with identical feed and underflow rates. The data shall show that installation of an EDI equivalent in design to that proposed for this project produced a decrease in effluent suspended

solids of at least 25 percent.

C. Feedwell: The flocculating feedwell shall be located outside of the EDI to diffuse the liquid into the tank without disturbance or formation of velocity currents. Baffled openings shall be provided near the water surface to allow scum to exit the feedwell.

1. The supports for the feedwell shall be located either above the liquid extending from the cage or bridge, or on the rake arms. Submerged supports from the rake arms shall be designed so as to minimize horizontal flow disruption.
2. No feedwell support or feedwell spliced connection shall be contained within the annular space formed between the feedwell and EDI. The depth of the feedwell shall be such as to provide proper detention time and an exit velocity at maximum flow that will not scour the settled sludge. The diameter, depth, detention time, and exit velocities shall match the process application calculations as evidenced by the required successful operating installations.
3. The feedwell shall be made of not less than 3/16-inch-thick steel plate with necessary stiffening angles.

D. Center Cage: The center cage shall be of steel box truss construction. It shall be provided with connections for the two sludge rake arms and feedwell supports if required. The cage top shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The cage and each arm shall be designed to withstand 150 percent of the design running torque of the drive without overstressing the members. Loading to develop the torque shall be considered as uniform loads applied to each arm individually.

E. Sludge Rake Arms: The mechanism shall include two long sludge rake arms of steel truss construction with spiral-shaped steel scraper blades and adjustable stainless-steel squeegees. Squeegees shall be fastened to the rake blades with stainless steel fasteners.

1. Scraper blades shall be designed for sufficient sludge transport capacity to handle the design solids loading rate, with the depth of the blade varying from a minimum at the tank periphery to a maximum at the tank center.
2. Blades shall properly convey settled sludge to the sludge withdrawal ring. Blades that move sludge away from the center column to the orifices of the withdrawal ring shall also be provided.
3. The arms shall be adjustable at the cage to assure an even level over the tank bottom.
4. The rake speed shall be sufficient to transport the necessary volume of sludge to the sludge outlet but shall not re-suspend settled sludge.

F. Sludge Withdrawal Ring (if used): If a sludge withdrawal ring is used, then the tank floor slope and sludge withdrawal ring design shall be verified by the clarifier equipment manufacturer. The sludge withdrawal ring shall be located and sized to prevent short-circuiting of the influent to the underflow. It shall be placed at a point of high sludge concentration. It shall be rectangular in cross-section as shown on the drawings, and shall remove sludge uniformly around the center of the tank.

1. The sludge withdrawal ring shall surround the center column. The Sludge ring shall include appropriate anchorage to the tank floor. The cross-section shall be tapered along its length to ensure a constant sludge velocity through the ring. Equally spaced orifices shall be cut into the outer ring wall. The orifices shall be sized to

avoid plugging. The outer ring wall shall be at a constant radius. The annulus between the column and the ring shall be filled with grout.

2. Sludge Withdrawal Ring Data – The submittal shall include data from side-by-side tests on identical full-scale operating clarifiers at least 80 ft. in diameter, with identical feed and underflow rates. The data shall show that installation of a sludge collection ring equivalent in design to that proposed for this project produced an average sludge blanket depth approximately one foot lower than a clarifier with only a conventional central sludge hopper.

2.5 SCUM REMOVAL

A. General: The clarifier manufacturer shall furnish two (2) skimming devices as part of each clarifier mechanism. Each skimming mechanism shall be arranged to sweep the surface of the sedimentation compartment, automatically removing scum and floating material to a scum box at the periphery of the tank.

B. Skimmer Construction: The rotating scum skimmer shall include a horizontal steel plate skimmer blade supported by vertical steel members extending up from the rake arms. The blade shall extend from a point 6 inches away from the influent feedwell to the hinged scum skimmer assembly at the tank periphery.

C. Scum Skimmer Assembly: A hinged scum skimmer assembly shall be mounted on the outer end of the skimmer blade. The hinged scum skimmer assembly shall be designed to form a pocket for trapping the scum. The hinged arrangement shall ensure continual contact and proper alignment between wiper blade, scum baffle, and ramp as the blade travels up the scum box ramp. The wiper blade shall have a wearing strip on its outer end, which contacts the scum baffle and a neoprene strip on its lower and inner edge. The neoprene wipers shall be a minimum 1/4-inch thickness. The scum is trapped as the wiper blade meets the ramp and is raised up the ramp to be deposited into the scum trough for disposal.

D. Scum Box: The scum box shall be of the size specified, supported from the tank wall and connected to the scum withdrawal piping. It shall be made of 1/4-inch-thick welded steel plate. The box shall have a scum trough, vertical steel sides, and a sloping approach ramp that extends from 1-1/2 inches above water level to 5-1/2 inches below. A similar ramp shall be provided at the opposite end to allow the skimmer blade to lower back to the operating position. A flexible connector shall be provided for connection to the Contractor supplied scum withdrawal piping in the tank wall.

E. Scum Flushing Valve: A valve shall be attached to the scum box which automatically opens and allows clarified liquid into the scum box to flush out solids. The valve shall actuate at every pass of the scum skimmer over the scum box, allowing sufficient delay after deposit of the solids before flushing begins. Delay and flush duration shall be adjustable. The opening and closing of the scum flushing valve shall be one smooth continuous movement. The valve shall provide 2 to 5 gallons of flush water per each pass of the skimmer assembly.

F. Scum Baffle: The baffle shall consist of 1/4-inch-thick x 12 inches deep fiberglass sections. In the area of the scum box the scum baffle shall extend to 24 inches starting approximately 6 feet before and ending 2 feet after the scum box. The baffle sections shall be curved and fastened to the launder wall with adjustable FRP support brackets, stainless steel fasteners, and anchor bolts.

2.6 EFFLUENT REMOVAL

A. Launder: A rectangular effluent launder (trough) shall be provided around the perimeter of the tank. The launder shall be formed as part of the concrete wall. A drop-out box shall be provided in the bottom of the launder at one point for collection and discharge of the clarified effluent.

B. Weir: An adjustable fiberglass weir shall be provided around the periphery of the tank at the water surface for removal of clarified effluent. The weir shall consist of 1/4-inch-thick x 9 inches deep fiberglass sections with 2-1/2-inch-deep 90-degree v notches at 6-inch intervals. The weir sections shall be curved and fastened to the launder wall with special large washers, anchor bolts, and hex nuts to allow vertical adjustment.

C. Effluent Trough Covers: All clarifier components shall be compatible with effluent trough covers.

2.7 ELECTRICAL

A. The equipment supplier shall furnish all electrical items specifically called for in this specification section. The Contractor shall supply and install all other electrical items required to place the equipment into service.

B. The Contractor shall supply and install all field wiring required, including but not limited to proper size wire, conduit, fittings, and supports.

2.8 ANCHORAGE AND FASTENERS

A. Anchor Bolts: All anchor bolts shall be a minimum of 1/2-inch diameter and made of type 316 stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment.

B. Fasteners: All structural fasteners shall be a minimum of 1/2-inch diameter and made of type 316 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

2.9 STAMFORD DENSITY CURRENT BAFFLE

A. General

1. Contractor shall submit certified test reports of the physical and mechanical properties of the product.
2. Contractor and Manufacturer shall coordinate the Stamford Density Current Baffle design and installation requirements with the clarifier mechanism, scum box, and launder effluent channel configurations.

B. Manufacturers

1. NEFCO
2. Fiberglass Fabricators
3. Approved Equal.

C. Design: The Stamford Density Current Baffle shall consist of a series of baffle panels

that are attached to the wall (or effluent trough wall for some clarifiers with in-board effluent troughs) to form an inclined, shelf-like surface around the entire inner periphery of the tank.

1. Each panel shall be molded of corrosion-resistant, UV-treated fiberglass.
2. The panel shall be a maximum of 8 feet in length and shall be curved to follow the curvature of the clarifier tank.
3. The width, inclination angle and mounting location of the baffle shall be determined based upon the clarifier configuration in order to provide optimum baffle performance. The panels shall be designed such that adjacent panels fit together without overlapping or cutting, and the completed baffle when installed, has a well-engineered and professional appearance.
4. The inclination angle of the baffle (as measured from the horizontal) and the horizontal projection of the baffle shall be defined by the manufacturer. Suppliers must provide CFD modeling results for the performance of the proposed configuration.
5. Provision shall be made to attach the panels to the clarifier wall and support them at the proper angle using a panel bracket. The panel and bracket shall be molded as an integral part of each panel, forming a baffle module, or separate panels and brackets may be supplied. If the panel and bracket are molded as an integral unit with adequate stiffeners, only one bracket is required per panel. A specially formed "free-end" bracket shall be provided to support the free end of the last panel where the run of panels is interrupted by an obstruction. Panels may be cut as required to fit around obstructions.
6. If separate panels and brackets are supplied, the panels shall be molded of fiberglass and shall meet the specifications of this section. The brackets shall be fabricated of 3" x 3" x 1/4" stainless steel angle and shall be triangular in shape, with the corners welded. Brackets shall be installed at a maximum spacing of four (4) feet. The panels shall be fastened to the brackets with stainless steel nuts, bolts and lock washers every 8 inches.
7. In the case of clarifiers/settling tanks with inboard launders, two scenarios are possible:

    a. If there is sufficient vertical clearance between the top of the blanket and the bottom of the launder to position the bottom of the baffle at least two feet above the top of blanket, then the baffle shall be mounted directly to the tank wall at or above that position.
    b. Where the clearance is more restricted, the baffle shall be mounted to the lower inboard corner of the launder trough. In this case, the width of the trough shall be taken into account when calculating the horizontal projection of the baffle, and the horizontal projection shall not be less than 24".

8. A method of interconnecting adjacent panels shall be provided such that the entire assembly forms a rigid structure capable of supporting its own weight plus snow and wind loads in the event the tank is out of service. The angled working surface of each baffle shall be sufficient in pitch and width to divert the flow and to create a self-cleaning action of the baffle itself.
9. Provision shall also be made to vent gases that may form beneath the baffle through 6" diameter half-round openings molded into the panel at its highest point. The vents shall aim radially toward the center of the tank, such that any bubbling and/or by-passing current is directed away from the weir, preventing short-circuiting, especially in cases where the panels are to be launder-mounted, with the vents sitting directly below the weir and scum baffle.

D. MATERIALS

1. Each panel shall have the following minimum physical properties:

   - Property Test Minimum Value
   - Tensile Strength ASTM D-638 18,000 psi
   - Flexural Strength ASTM D-790 26,000 psi
   - Flexural Modulus ASTM D-790 1.01 x 106 psi
   - Barcol Hardness ASTM D-2853 34
   - Notched Izod ASTM D-256 10 ft-lbs/in
   - Water Absorption ASTM D-570 0.08%

2. Each baffle panel shall be molded of fiberglass-reinforced plastic. The resins and fiberglass reinforcing material shall be consistent with the environmental conditions and structural requirements.
3. The resin shall be an isophthalic polyester resin with corrosion-resistant properties, Corezyn COR75-AQ-010 or equivalent, suitable for use in submerged waste treatment applications. The resin shall not contain fillers except as required for viscosity control. For viscosity control, a thixotropic agent up to 5% by weight may be added to the resin. The resin shall be treated to provide UV suppression.
4. Glass reinforcement shall consist of chemically bonded surfacing mat and chopped strand roving. Surfacing mat shall be Type C veil. The glass reinforcement shall be 357-211 PLN CTC chopped strand roving or equivalent. The glass content of the finished laminate shall not be less than 30% by weight. The nominal thickness of each baffle panel shall be 1/4" ±1/16 inch thick with resin-rich surfaces and edges to prevent migration of moisture and fiber "blooming." The baffle shall be black in color.
5. The upper surface of each panel shall be mold smooth, and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks, or crazes. The upper surface of the baffle shall be reinforced with one layer of surfacing veil followed by 2 ounces or more of chopped strand roving. In addition, the vertical mounting flange (return flange on launder mount applications) shall be reinforced with one layer of 24 oz woven roving.
6. No other glass product is permitted between these layers. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking.

E. Installation

1. The Contractor shall field verify existing dimensions and install the baffle in accordance with the contract drawings, approved shop drawings and Manufacturer's recommendations. Mounting holes shall be factory drilled. Field cutting of baffle panels will be allowed to complete the structure and accommodate in-tank obstructions. All field cut or drilled edges shall be coated per the Manufacturer's recommendations to prevent fiber blooming or fraying. All the fasteners required for installation shall be supplied by the baffle manufacturer. The baffle panels shall be attached to the wall using 3/8" x 3-3/4" concrete expansion anchors with oversized 1/8" x 2-1/4" stainless steel washers, and hex nuts, Adjacent baffle panels are fastened together using 1/4" bolts, two flat washers, lock washer, and hex nut. All of the installation fasteners shall be stainless steel.
2. The density current baffle shall extend completely around the tank and shall be

level, rigid, and free of sway that could work anchors loose or cause undue wear.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The equipment shall be installed properly to provide a complete working system.

B. Installation shall follow the supplier's recommendations. Lubricate in accordance with Manufacturer's instructions.

C. The Contractor shall adjust for true plane of rotation and grout the floor in accordance with the Manufacturer's recommendations.

D. The equipment supplier shall furnish an electronic copy of the operation and maintenance manual, which will be retained at the installation site to assist plant operators. The manual shall include the supplier's erection and assembly recommendations and a complete list of recommended spare parts.

3.2 FIELD QUALITY CONTROL

A. Performance Test:

1. All labor, materials, and test apparatus necessary for conducting the above tests shall be furnished by the Contractor at no additional cost to the Owner.
2. Torque Tests: The entire sludge collector mechanism shall be statically load tested by loading the rake arm with 150 percent of the specified design running torque. The test shall verify the torque overload control device settings for alarm and motor cutout. One truss arm shall be anchored, and the load measured to demonstrate the rake arms', cage's, and drive unit's ability to withstand the specified torque. Sketches and calculations shall be submitted illustrating how the torque will be applied prior to the test taking place.
3. Operation Tests: The Contractor shall operate the mechanism in a dry tank for a minimum of 4 continuous hours before flow is allowed to enter the system. There shall be no binding, jerky, or unusual motion exhibited during this run-in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 4-hour observation test run. If the unit should fail under any of these conditions, the test shall be halted, and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be repaired or replaced and the test re-run.

B. Manufacturer's Field Services: The equipment supplier shall provide the service of a qualified representative as follows:

1. During Instllation: One (1) trip during installation of the mechanism (only required for the first mechanism if more than one are being and installed).
2. Inspection, Training, and Start-Up: One (1) day per mechanism to inspect the mechanism installation, assist in start-up, and instruct plant personnel in the proper operation and maintenance of the mechanism.

END OF SECTION 44 46 26

SECTION 444627 – CLARIFIER TROUGH COVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUBMITTALS

A. Product Data: Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction, including resins and glass fiber content and layout for FRP constructions.

B. Shop Drawings: Detailed drawings showing equipment fabrication, dimensions, method of attachment including number, locations, and size of fasteners and weights of fabrications. Manufacturer's recommended Cover dimensions, mounting configuration, and location for each application.

C. Maintenance Data: Include any maintenance manuals specified in Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's instructions for handling.

1.4 WARRANTY

A. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. NEFCO, Inc.
2. EDGENG
3. Approved Equal

2.2 DESIGN, GENERAL

A. The trough cover shall consist of a system of molded fiberglass panels that are attached together to form a continuous cover over the clarifier effluent trough, weir, and scum baffle. The cover shall be designed and manufactured to inhibit incident sunlight from striking the surfaces of the trough and weir. Each Cover section shall be molded of UV-protected fiberglass and shall be opaque to sunlight. Individual sections shall be a minimum of four feet in length and curved to follow the curvature of the Clarifier. The cover shall extend over the trough and weir as far as possible and

may extend to a point immediately inside the scum baffle so long as the cover does not interfere with the sweep arm. The cover shall be designed such that adjacent panels fit together properly and the completed cover, when installed, forms a rigid structure and has a well-engineered and professional appearance.

B. Provision shall be made to support the cover in such a manner that the panels are held securely in place, with the panels hinged to provide access to the trough and weir for inspection and maintenance. Neither the cover nor the means used to support it shall interfere with effluent flow over the weir or within the trough. Cover supports shall not impede personnel from entering and traversing the trough. Cover supports that cantilever from the outer effluent trough wall without support at the weir wall are unacceptable.

C. The cover shall be designed to open away from the operator and toward the center of the tank. Each Cover segment shall consist of a fixed Mounting Section and one or more Cover Sections, each connected to the Mounting Section by a continuous stainless-steel hinge. The Mounting Section shall provide a rigid mount for the Cover Sections and ensure the proper fixed spacing between them. The Mounting Section is fastened to the weir wall with FRP and/or stainless steel brackets and extends inward to a point just inboard the scum baffle. The hinged Cover Sections extend outward toward the outer trough wall and swing open to allow inspection and maintenance of the trough and weir. The hinge point of the cover is positioned between the weir and the scum baffle to ensure full visibility of the trough and weir when the cover is open. In the closed position, the Cover Sections rest on an FRP support flange attached to the outer trough wall.

D. The hinged cover shall be designed such that every panel is allowed to open independently of another. The space between closed panels shall be filled by a suitable gasket attached to the flange on one side of each panel.

E. Provision shall be made to secure the cover in the closed position for safety and security. This is accomplished by means of an easily operated, spring-loaded latch mechanism that secures the hinged Cover Sections. Handles or lift rings may also be required for some panels. A means of limiting the travel of the hinged Cover sections, in the form of a restraint cable, shall also be provided to protect against damage.

F. Where the circumference of the trough is interrupted by a bridge support or another obstacle, a fixed panel(s) shall be installed over the trough beneath the support such that the surface of the cover is continuous around the entire tank. Alternatively, vertical panels may be selected by the Owner to be installed on both sides of the bridge supports to block out sunlight.

G. The cover shall be designed to support common wind and snow loads. Adequate stiffeners shall be integral to each panel. Panels reinforced with balsa or foam cores are not acceptable, except where a single or double-length reinforced walk-on section is used for safe entry to the trough.

2.3 MATERIALS, GENERAL

A. Each cover panel shall be molded of fiberglass-reinforced plastics. The resins and fiberglass reinforcing materials shall be consistent with the environmental conditions and structural requirements of the application.

B. The resin shall be an industrial quality, isophthalic polyester resin with UV suppression additives, Corezyn COR75-AQ-010, or equivalent. The resin shall be pigmented to ensure that the resulting part is opaque. The glass reinforcement shall be chopped strand roving, 357-211 PLN CTC, or equivalent, with a minimum 1/2-inch strand length. Additional reinforcement in the form of stiffening ribs shall be added when necessary. The glass content of the finished laminate shall be not less than 30% by weight. The nominal thickness of each panel shall be 1/4 inch. The laminate shall consist of a 20 mil outer layer of marine quality white gelcoat, followed by chopped strand roving. The laminations shall be dense and free of voids, dry spots, cracks or crazes. All factory-trimmed edges shall be sanded and sealed. The finished laminate shall have a smooth, even appearance.

C. Fasteners, handles, hinge and latches shall be stainless steel. The weir wall mounting brackets shall be stainless steel, FRP or a combination of the two. The latch/handle shall be a spring-loaded mechanism with a positive detent positioned to indicate the closed/locked position of the handle. The latch is activated by pressing down on the spring-loaded handle and turning it. The magnetic latch is disengaged by pulling upward on the cover, ring or other fixture with sufficient force to overcome the force of the magnet.

D. The tether or restraint cable shall consist of a length of stainless steel cable secured to the tank wall and the hinged Cover Section by means of stainless steel eyebolts. The length of the cable is selected to limit the travel of the cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Contractor present, for compliance with requirements for installation tolerances and other conditions affecting performance of Covers.

3.2 INSTALLATION AND OPERATION

A. Comply with manufacturer's detailed written instructions for installation.

B. Installation and operation shall be in accordance with instructions and recommendations provided by the manufacturer.

C. Verify that all units are in condition suitable for installation; are properly fitted, assembled and installed; are accurately leveled and aligned, and are ready for satisfactory operation.

D. Manufacturer shall assist in coordinating the Trough Cover design and installation requirements with the clarifier mechanism, scum box and trough effluent channel configurations.

E. The Cover sections shall be mounted to the weir wall on stainless steel or FRP brackets. The free end of each Cover panel shall be supported at the outer tank wall by an FRP support flange that attaches to the entire periphery of the tank.

F. The Contractor shall install the cover in accordance with the Contract Drawings, manufacturing drawings, and manufacturer's recommendations. Field cutting of

panels shall be allowed to complete the structure and accommodate in-tank obstructions. All cut ends shall be dressed as per the manufacturer's recommendations.

G. All fasteners and brackets required for the installation shall be Stainless Steel and shall be supplied by the Cover manufacturer. The support flange and weir wall brackets are installed using 3/8" x 3-3/4" expansion anchors with flat washers, lock washers, and hex nuts.

3.3 PROTECTION

A. The Contractor is solely responsible for protecting all existing surfaces, structures, and other facilities adjacent to or in the vicinity of the work being performed. The Contractor shall repair and/or pay for all damages resulting from his operations or personnel to existing facilities and shall settle in full all damage suites which may arise as a result of his operations.

END OF SECTION 44 42 24

SECTION 44 46 28 – POST AREATION EQUIPMENT

PART 1 - GENERAL

1.1. SUMMARY

A. This section covers furnishing a complete cascade post aerator system as specified herein. The cascade post aerator, further described as a low profile cascade aerator (LPCA), is designed for installation in a concrete basin as shown on the Plans and Drawings and shall be a rectangular, open channel type, low profile, free flowing aerator with hydraulic loading capacity of 0.5 MGD (minimum daily flow), 12 MGD (maximum), and 6 MGD average daily flow. Based on influent dissolved oxygen concentration (D.O.) minimum of 2 mg/l, and based on typical municipal wastewater characteristics, an effluent D.O. reading of 6.0 mg/L can be achieved. The LPCA shall be the last piece of process equipment, located at the outfall of the wastewater treatment plant.

B. CONTRACTOR: Shall furnish all labor, materials, equipment, and incidentals as shown, specified and required to provide a complete LPCA system as specified herein.

C. GENERAL: Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations by the named equipment manufacturer. The LPCA shall be the last piece of process equipment prior to the outfall of the wastewater treatment facility.

D. MANUFACTURER of the LPCA equipment shall be vested with unit responsibility for the proper function of the complete low profile cascade aerator system as specified. The patented LPCA with trapezoidal air infusion plates shall be a current, standard product of a manufacturer having extensive experience and regularly engaged in the production of such equipment with proven performance test results.

1.2. REFERENCES

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

1. American Society for Testing and Materials (ASTM)
2. ASTM A167 – Type 304L & 316L Stainless Steel
3. American National Standards Institute (ANSI)
4. American Welding Society (AWS)

1.3. SUBMITTALS

A. Submit for approval the following:

1. Provide one electronic manual in PDF format and/or four (4) complete approval submittal manuals. Manuals shall be bound and include scope, process calculations, catalog cuts, and drawings.
2. Manufacturer’s literature, illustrations, and engineering data including total weight of each unit, connection details, and performance data.

3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
4. Literature describing the equipment and showing all important details of construction and dimensions. Dimensions shall show overall size and space requirements including that for installation, leveling, dismantling and maintenance.
5. Cross sections and details, as to show that all components are in conformance with the intent of the specification and are satisfactory from the standpoint of design and physical arrangement.

B. Operations and Maintenance Manuals

1. Submit one electronic Manual in PDF format and/or four (4) complete operation and maintenance manuals. Manuals shall be bound and include reinforced 8.5" x 11" paper, 11" x 17" B-size drawings when practical, and individually sleeved D-size drawings.
2. The manual shall include: Equipment Introduction and Operation, Warranty, Troubleshooting, Maintenance, and Drawings.

1.4. QUALITY ASSURANCE

A. One Cascade Post Aerator Manufacturer shall supply all equipment specified in this Section.

B. Basis of Design: The structural, mechanical and process design for the cascade post aerators are based on information provided by the first-listed low profile cascade aerator Manufacturer. The cost of any changes and modifications due to furnishing equipment other than that specified shall be borne solely by the CONTRACTOR. The CONTRACTOR shall also be responsible for any substitute equipment furnished complying with the full intent of the specifications, and be responsible for any patent infringement to the LPCA**.**

Fundamental changes in the configuration of the post aerator system will not be allowed. LPCA equipment submitted as equivalent products shall not require additional basin area or depth to achieve the designated performance requirements. The CONTRACTOR shall submit complete drawings, specifications and supporting documents, identifying all proposed changes, a list of installations and certified performance data, to the ENGINEER for approval at least 14 days prior to bid date.

C. Responsibilities

1. The LPCA Manufacturer is responsible for delivery of equipment and supplies required under these specifications. The CONTRACTOR is responsible for proper off-loading and storage at the delivery location, and coordination and integration of all equipment required for installation in the concrete basin, and all other associated work shown on the drawings and specified in the Contract Documents. The CONTRACTOR is responsible for ensuring that the LPCA system shall be properly coordinated and will function as a unit in accordance with these specifications. The CONTRACTOR shall bear ultimate responsibility for equipment coordination, installation, operation, and guarantees.

D. Workmanship

1. Workmanship in the fabrication of the LPCA system shall be of high quality and include the following requirements. The assembled channel aeration baffle assembly shall have members that are straight and true. Structural distortions, warps, and other defects shall not be present in the aeration assemblies before or after installation in the basins. The topmost corners of all Air Infusion Plates shall be ground round and smooth.

1.5. PRODUCT DELIVERY, STORAGE, AND HANDLING

A. The trapezoidal Air Infusion Plates and Air Infusion Baffles shall be factory assembled to the channel dividers and shall be shipped in sections. All equipment shall be shipped with suitable in-transit protection.

B. Lifting straps in lieu of chains are to be employed when applicable (by CONTRACTOR).

C. Equipment shall be stored and protected in accordance with the manufacturer's recommendations.

1.6. SYSTEM DESCRIPTION

A. The LPCA equipment shall consist of a plurality of channel dividers with Inlet Flow Control Optimizer / Equalizer Gate and weirs. The inlet weirs shall be for flow control and each shall increase in height from one channel to the next. Each channel shall be provided with a plurality of low head aeration baffles spaced as shown on plans. Each aeration baffle shall be provided with patented trapezoidal air infusion plates as shown to provide optimum transfer efficiency. At peak flow the system will offer even flow distribution to each channel. To prevent short circuiting and critical for system process performance, channels and aeration baffles are constructed so as to eliminate all gaps.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

A. The equipment shall be manufactured by:

1. Jim Myers & Sons, Inc. (JMS)
2. Smallberry Manufacturing
3. Approved Equal

B. The equipment described by this specification defines minimum equipment requirements as supplied by the first-listed manufacturer. All unforeseen costs associated with any deviation from this specification shall be the sole responsibility of the Contractor.

C. The equipment shall be the product of a manufacturer engaged in the design and manufacture of similar equipment in successful operation in similar applications. The manufacturer shall have experience with 20 installations of the same type of equipment as specified herein with successful operation for a minimum of 10 years.

D. Pre-qualification requires manufacturers to submit the following 30 days prior to bid:

1. A list of at least 10 previous installations, including contact information, of similar size, design, and complying with the requirements as set forth within this specification.
2. Preliminary drawings and process calculations specific to this project.
3. A letter stating that their proposed design complies with all requirements as specified herein. If there are deviations from the specification a letter must address each deviation in detail.
4. Equipment shall be manufactured in the United States by US citizens fully certified by the American Welding Society for the tungsten inert gas (TIG) welding process to standard AWS D1.6. Letters of current certification shall be provided prior to bid and within the submittals.

2.2. MATERIALS OF CONSTRUCTION

A. LPCA equipment shall be supplied by Manufacturer and shall be fabricated of Type 304 stainless steel and shall include all necessary stainless steel anchor bolts, seals, and accessories.

1. Channels, Air Infusion Plates, Aeration Baffles and Closure Plates are to be fabricated with Type 304 SS with a minimum thickness of 0.120” (11 gauge).
2. Influent Flow Control Optimizer / Equalizer Gate, trapezoidal in design, is to be fabricated with Type 304 SS.

B. Hardware: All field assembly anchor bolts, bolts, nuts, washers and seal material shall be supplied by Manufacturer:

1. Nuts, fasteners, and anchor bolts (3/8” diameter) are to be Type 304 SS.
2. Seal Material: 3M 3/8” round ribbon sealant to be provided by Manufacturer.

2.3. LOW PROFILE CASCADE AERATOR (LPCA) SYSTEM

A. The LPCA system shall be fabricated in accordance with the details indicated on the drawings and the requirements specified herein.

B. The LPCA is a static system design and is designed and constructed for the minimum flow and maximum flow as specified and utilized in the treatment plant’s post aeration process to increase the aerobic effluent dissolved oxygen content.

C. The LPCA as specified is designed for installation (insertion) in the treatment plant post aeration concrete structure (by CONTRACTOR) as shown on the Plans, and utilized to increase the plant effluent dissolved oxygen content. The LPCA shall be the last piece of process equipment, located at the outfall of the wastewater treatment plant.

D. The unit shall be structurally reinforced by attaching structural bracing to the top of the channel dividers as shown on the drawings. The unit shall be sealed under the channel dividers and anchored in the concrete channel as directed by the

manufacturer’s instructions. Said sealing of all channels to the concrete channel floor to eliminate all gaps is critical for system process performance.

E. The Influent Flow Control Optimizer / Equalizer Gate, for the specified design minimum and maximum influent hydraulic loading, directs the variable influent flow to the appropriate channel or channels to optimize system performance and offers a patented integral air infusion plate for greater aeration performance during periods of low flow. Air infusion plates and aeration baffles will be trapezoidal shaped to optimize air infusion at minimum flows and achieve the effluent dissolved oxygen concentration at the full range of flow per 1.1.A. At peak flow the system must be designed to offer even flow distribution to each channel.

PART 3 - EXECUTION

3.1. INSTALLATION

A. The Contractor shall install the aerator equipment where indicated on the contract drawings and in strict accordance with the manufacturer's recommendations.

B. Conform to the requirements of Section 03300, and the following:

1. Set all anchor bolts using templates as required.
2. The LPCA shall be fabricated for insertion into a concrete basin/channel as shown on the Drawings.
3. All smooth concrete surfaces shall be true plane within 1/4" in 10'-0" as determined by a 10'-0" straight edge placed anywhere on the surface, in any direction.
4. Abrupt irregularities shall not exceed 1/8".
5. The unit shall be structurally reinforced by attaching structural angle bracing to the top of the channel dividers as directed by the manufacturer's instructions.
6. Per manufacturer's instructions, the unit shall be sealed under the channel dividers and aeration baffles by Contractor with seal stripping (furnished by Manufacturer) and anchored in the concrete basin to eliminate short circuiting. Said sealing of all channels to the concrete encasement floor to eliminate all gaps is critical for system process performance.

C. Concrete basin (by CONTRACTOR) as shown on the Plans is to include influent and effluent chambers to be sized so as to not exceed indicated maximum water elevations. Influent chamber (by CONTRACTOR) to include energy dissipation device if necessary to reduce water velocity impact on influent distribution and to evenly distribute flow to Influent Flow Control Optimizer / Equalizer Gate.

D. CONTRACTOR will provide concrete encasement/basin with the sloped floor and dimensions as specified on Contract Drawings. CONTRACTOR understands the slope and finish tolerances are critical to the performance of the post aerator and are as noted in 3.1.B., Contract Drawings and Manufacturer’s recommendations.

E. CONTRACTOR must connect accessory parts as required to ensure a complete and operable system as intended. Contractor to exercise great care in erecting and leveling the weir plates so that the units are at the elevations shown on the Drawings

or specified herein, and to ensure the aeration system is mounted and sealed to floor and walls to eliminate short-circuiting as intended and per Manufacturer's Instructions.

F. LUBRICANTS AND LUBRICATING EQUIPMENT

1. Anti-seize shall be applied to the threads of all stainless steel bolts before assembly at the factory and field assembly.

3.2. WARRANTY

A. The supplier shall guarantee in writing that the equipment furnished is appropriate for the intended service and shall be free of manufacturing and fabrication defects in material and workmanship for a period of one (1) year after the equipment is satisfactorily placed into service. If the equipment is not placed into service within 6 months of delivery, the 1 year guarantee period shall commence 6 months after delivery.

3.3. MANUFACTURER'S SERVICES

A. Manufacturer's Field Services: The CONTRACTOR shall provide the following services in addition to any other services specified herein, and required by these Specifications.

1. A factory trained manufacturer's representative shall be provided for a minimum of one (1) trip and a minimum of eight (8) hours to provide installation supervision, start-up and field testing services, and O&M training services. The installation services shall be coordinated between the CONTRACTOR and the Manufacturer. The start-up and field testing services, and the O&M services shall be coordinated with the ENGINEER.
2. After installation supervision and field testing services by the manufacturer, the CONTRACTOR shall submit to the ENGINEER, a certification letter on the manufacturer's letterhead and signed by the manufacturer certifying that the equipment was installed per the manufacturer's recommendations.
3. The manufacturer shall provide start-up reports covering installation inspection and start up activities.
4. The manufacturer shall provide operator training to all required plant personnel.

B. All costs, including travel, lodging, meals and incidentals for Manufacturer service shall be included in te CONTRACTOR'S bid.

END OF SECTION

SECTION 44 46 30 - DISK FILTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
B. Section 26 29 00 – Manufacture Control Panels

1.2 SUMMARY

A. This Section includes the following equipment:

1. Pile cloth disk filters and ancillary equipment

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following.

1. Detail each equipment assembly, including make, model, rated capacities, furnished specialties, accessories, details of construction relative to materials, profiles, finishes, description of materials, bill of materials, motor data, pump data, the weight of each component, equipment structural design calculations, and process design calculations, description of surface preparation, shop priming, and finish painting, indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Power and control wiring diagrams, including terminals and numbers.
3. Equipment drive data including equipment assembly data, mounting details, grit collecting equipment locations, motor nameplate data per NEMA MG 1, and include any motor modifications.
4. Shop Drawings to include complete dimensional data, equipment outline dimensions, equipment drive data, equipment assembly data, mounting details, grit collecting equipment locations.

B. Product Test Reports: Based on evaluation of tests performed by Manufacturer and witnessed by a qualified independent professional engineer, indicate compliance of grit collecting equipment for applicable codes, based on comprehensive testing within the last two years of current products.

C. **Maintenance Data: For grit collecting equipment to include in the maintenance manuals specified in Division 1. Include the name, address, and telephone number of the Manufacturer's nearest authorized service representative.**

1.4 QUALITY ASSURANCE

A. The equipment specified herein shall be located as shown or described and installed in conformance with the Manufacturer's suggested method. The unit(s) shall be

furnished and installed with all necessary accessory equipment and auxiliaries, whether specifically mentioned in these specifications or not, and as required for an installation incorporating the highest standards for the type of service specified, including field technician representation during startup of the unit(s), and instruction of the Owner's personnel in the care, operation and maintenance of all equipment.

B. All equipment covered by these specifications shall be furnished by one Manufacturer, and shall be complete including motor and appurtenances. The equipment shall be the product of a single manufacturer regularly engaged in the production of equipment for the specified use. The Manufacturer shall have the sole responsibility for the proper functioning of the equipment as furnished.

C. Installer Qualifications: Engage an experienced installer who is an authorized representative of the grit collecting equipment Manufacturer for both installation and maintenance of the type of units required for this Project.

D. The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of (2) trips and (8) eight hour days at the jobsite to inspect the installing contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.

E. The manufacturer shall have a free troubleshooting help line available 24 hours a day, 365 days per year for the life of the plant.

F. The filter supplier shall have experience in the design and manufacture of cloth media filters for a minimum of ten (10) years and shall be able to demonstrate a minimum of fifty (50) installations within the United States in municipal wastewater applications with cloth media.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and handle equipment in a manner to avoid damage. Comply with the Manufacturer's rigging instructions for handling and keeping the equipment stored in a clean, dry location free from construction dust, precipitation, and excess moisture.

1.6 WARRANTY

A. Warranty shall be provided per Specification Section 01 74 00.

1. Warranty shall be for unlimited usage of the equipment.
2. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the manufacturer shall provide and install a replacement part without cost to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Aqua Aerobics – Aquadisk Tertiary Filters

2.2 DESIGN REQUIREMENTS

A. There shall be two (2) Model ADFC-54 x 10E-PC AquaDisk filter(s) as manufactured by Aqua-Aerobic Systems, Inc., of Loves Park, Illinois. The contractor shall furnish all labor, materials, equipment and incidentals required for the installation of the disk filters as shown on the drawings and as specified herein. The installation contractor shall provide the wall spool piping and all external piping. Effluent weir assembly shall be provided by the installing contractor.

B. Each unit will include:

1. Basin Mounting Brackets and Hardware
2. Drive Assembly
3. Center tube Assembly with Cloth Media Disks
4. Backwash System
5. Backwash/Waste Pump Assembly
6. Valves
7. Influent Weir
8. Pressure Transducer Assembly
9. Float Switch
10. Vacuum Transmitter
11. Electrical Controls with Internal Components

C. All motors, pumps, and bearings shall be designed for continuous duty and long operating life in a high-humidity atmosphere. All motors and pumps shall be 460 volt, 60 hertz, 3 phase.

2.3 PERFORMANCE REQUIREMENTS

A. The filter shall be capable of filtering effluent from a Secondary process. Total design, for (2) new and (2) existing filters, shall be for:

1. 6 MGD Average Daily Flow
2. 12 MGD Maximum Daily Flow
3. Filter influent total suspended solids (TSS) concentration shall be 15 mg/l daily average and 25 mg/l maximum at average daily flow rate.
4. Filter effluent total suspended solids concentration shall not be greater than 5 mg/l based on a monthly average.
5. The filtration system shall be able to treat 100% of the maximum design flow to meet the above design conditions with one unit offline.
6. Manufacturer shall provide certified third party testing or peer reviewed journal article demonstrating the ability of the filtration technology to remove greater than 90% of microplastics.

2.4 COMPONENTS

A. FILTER DISK BASIN

1. Each filter shall be installed in a concrete basin. Each filter shall be provided with a 6” manually operated butterfly drain valve. Valve shall be provided with ductile iron body, aluminum bronze disk, stainless steel shaft and EPDM seat. Valve shall

be Nibco or approved equal.

2. Each filter basin shall be fitted with 304 stainless steel mounting brackets to accommodate attachment of the filter components to inside of the basin. All mounting brackets shall be attached to the inside of basin wall with stainless steel anchors and hardware. Through the wall spool piping and all filter external piping shall be provided by the Installing Contractor.

B. DRIVE ASSEMBLY

1. Each filter shall include an adjustable drive assembly with a gearbox, nylon drive sprocket, acetal drive chain with 304 stainless steel link pins, and a 304 stainless steel chain guard. The gearbox shall be parallel in-line helical type, AGMA Class 1 with a **3/4 HP drive motor rated for 460 volt, 3 phase, 60 Hz**. Gear reducer shall be Nord or approved equal. Drive motor shall be Nord, Weg, Baldor, or approved equal.
2. To reduce energy demand, the drive assembly shall rotate the disks only during backwash. Systems requiring constantly rotating disks during filtration will not be acceptable. Belt drive systems or systems with multiple drive units per filter will not be acceptable.
3. If motors and gearboxes require routine maintenance, and are not accessible from the outside tank side walls, the equipment manufacturer shall provide an internal access platform between the tank side walls and motors and gearboxes.

C. CENTERTUBE ASSEMBLY

1. Each centertube assembly shall include a minimum 1/4” thick 304 stainless steel centertube weldment, driven sprocket, wheel assemblies, 304 stainless steel disk segment rods, and frame and cloth assemblies.
2. Each centertube assembly shall also include a Viton v-ring effluent port seal which provides superior chlorine resistance.
3. Materials other than Viton are not acceptable for seal materials.
4. Systems with swivel joints requiring routine lubrication are not acceptable.
5. The driven sprocket shall be multi-segment made of UHMW polyethylene.
6. All fasteners shall be stainless steel.

D. CLOTH FRAME

1. Each cloth disk assembly shall be comprised of six (6) individual segments, each consisting of a cloth media sock supported by an injection molded glass filled polypropylene frame with corrosion resistant assembly hardware.
2. Cloth/frame assemblies shall be constructed such that each segment is easily removable from the centertube, without special tools, to allow for removal and replacement of the cloth at the point of installation.
3. Systems requiring special tools and/or the return of media segments to the factory for replacement will not be considered.

E. FILTER MEDIA

1. Each cloth disk assembly shall have a minimum of 53.8 square feet of effective submerged filtration area. Each disk shall be divided into no more than six (6) segments and shall be easily removable for service.

2. If the wet weight of the filter disk segment is greater than 50 pounds, a lifting mechanism shall be provided.
3. Each basin shall include ten cloth disk assemblies.
4. Each filter unit shall have a total of**: 538 square feet of minimum effective submerged filtration area.**
5. Cloths shall be of fiber pile construction having a nominal filtration rating of 10 microns. Granular media and screens having structured identical openings shall not be allowed.
6. The cloth media shall have an active filter depth of 3 to 5 mm to provide additional collisions between solids particles and the media within the media depth, resulting in capture of solids across a broader particle range. The cloth depth shall also provide storage of captured solids, reducing backwash volumes while maintaining an operational headloss. Woven mesh or microscreen type media with no filtration depth are not acceptable.
7. Individual pile fibers shall be held in place by a support backing integral to the media. To facilitate proper flow of backwash water through the cloth, the medium's back side shall be of open construction consisting of 10% open area at least 50 times larger than the nominal filtration media in any direction. Media that uses sewn in support structures, which have the potential to prevent free flow through the media, shall not be allowed.
8. Cloth strength is critical to ensure long term performance of the media. Cloth media breaking strength and elongation shall be tested in accordance with ASTM Standard D5035 2R-E method by an ISO certified laboratory specializing in textile testing. Breaking strength shall be in excess of 200 lbf (890 N) in the warp and the weft direction. Elongation shall be less than 10% at 60 lbf (270 N) in the warp and the weft direction. Test reports shall be provided with submittals to demonstrate compliance with this requirement.
9. To avoid excessive media movement, deformation and folding during backwash, the maximum distance between cloth restraints must not exceed 36 inches.

F. FILTER HYDRAULICS

1. During filtration, the filter unit shall operate in a static condition with no moving parts.
2. The filter system shall provide for the collection of filtered solids on the outside of the cloth media surface to allow for the direct contact of cleaning systems.
3. Filtered effluent shall be used for backwashing.
4. The filter flow path shall be from the outside of the cloth frame to the inside. Systems with flow paths from the inside to the outside of the cloth frame that collect filtered solids and plastic debris on the interior surfaces of the cloth frame will not be acceptable.
5. Only media area below the effluent weir elevation will be considered in the filtration area calculation since this is the only area that is submerged and available for filtration 100% of the time.
6. Submittal information shall include calculations that verify the effective filtration surface area. Media surface fused directly to support structure such that water cannot pass through the media shall not be included in these calculations
7. The operator shall be able to bring a drained filter on line by simply opening the influent isolation device. If the filter design is such that it must be filled with water

before the influent isolation device is opened to prevent damage to the filter media, an automated process that sequentially brings the filter back on line with a single switch shall be provided to prevent accidental media damage. The automated process shall activate a minimum 6" diameter motorized valve to fill the filter with effluent or other clean water source in not more than five minutes, verify that the filter is full, and open the motorized influent isolation device.

8. Because of the frequency of the backwash and misting associated with spray systems, designs that utilize high pressure spray or a moving vacuum head as the sole means of solids removal will not be acceptable.

G. BACKWASH AND SOLIDS REMOVAL SYSTEM

1. The backwash function shall incorporate a pump that draws filter effluent through the cloth as the media rotates past the fixed backwash shoe, thereby removing accumulated solids from the cloth surface.
2. Each disk shall be cleaned by a minimum of two backwash shoes, one on each side. The backwash shoes shall remain in a fixed position. Springs shall be used to maintain the proper tensioning of the backwash shoe against the media surface.
3. The backwash shoe shall be in direct contact with the cloth to ensure effective media cleaning. Systems utilizing media cleaning mechanisms that do not contact the filter media will not be acceptable.
4. Neither the cloth / support assemblies nor the backwash shoes shall include any gridwork overlays or other interferences that would prevent direct contact of the backwash shoes with the cloth fibers.
5. The backwash system shall include 304 stainless steel backwash shoe supports with UHMW backwash shoes, 316 stainless steel springs reinforced PVC flexible hose with stainless steel hose clamps, 304 stainless steel backwash manifolds, and PVC sludge collection manifold.

H. BACKWASH/WASTE PUMP ASSEMBLIES

1. Each backwash/waste pump assembly shall include two backwash/waste pump(s), valves and gauges. In the external piping shall be backwash and solids waste valves, 3" recirculation ball valve(s), 3" manually operated flow control gate valve) for each pump, vacuum gauge(s), and pressure gauge(s).
2. The backwash/waste pump(s) shall be shipped loose for field installation by the installing contractor. Backwash piping between the filter basin and pump(s) as well as piping following the pump(s) shall be supplied by the installing contractor. Installing contractor shall supply unions or flanges for service, and interconnecting wiring.
3. The backwash/waste pump(s) shall be a Gorman Rupp model 12B20-B, externally mounted centrifugal pump. Pump shall be provided with a **2 HP, 460 volt, 3 phase, 60 Hz motor and operate at 1750 RPM**. Pump shall be rated for **130 gpm at 23.2 ft TDH** with 12.2 ft allowable discharge head after losses in internal filter piping have been accounted for. Motor shall be Baldor, Teco, Weg or approved equal. Backwashing shall be initiated by tank water level, timer, or manually through the operator interface. Operator shall have the ability to specify backwash time interval elapses through the operator interface. The backwash water shall be pressurized by the filter's backwash/waste pump for discharging from the filter system. Systems utilizing non-pressurized backwash flow will not be accepted.

Backwash pumps using a belt drive shall not be acceptable due to routine tensioning and other maintenance requirements.

4. Each pump shall be provided with a painted steel support stand with wedge anchors.
5. Pump manually operated threaded gate valve shall be class 125 bronze with screw in bonnet, non-rising stem, and solid wedge. Valve shall conform to MSS SP-80 and shall be Nibco or approved equal.
6. The 3 inch threaded ball valves shall be a two-piece, full port, with a brass body. Valves and shall be Nibco or approved equal.
7. The vacuum gauge(s) shall have a minimum 2.5" dial with all stainless steel welded construction, 0-30" Hg vacuum range, liquid filled, ¼" NPT process connection, 316 stainless steel bourdon tube and tip material, and bronze socket material, Ashcroft or approved equal.
8. The pressure gauge(s) shall have a 2.5" dial with a black painted steel case, 0-15 psi, heat resistant polycarbonate window, ¼" NPT process connection, "C" shaped bronze bourdon tube, and brass socket material, Ashcroft or approved equal.
9. Filtering shall not be interrupted during normal backwashing and solids waste discharge.

I. VALVES

1. Each filter shall include five 2" backwash valve(s). Valve(s) shall be 2 piece, flanged end, ASTM A351 Grade CF8M stainless steel body, 316 stainless steel ball and stem, fullport, with a **115 volt, single phase, 60 Hz, open / close service electric actuato**r. Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal. Valve actuator shall include a compartment heater and limit switch feedback to the microprocessor in both the open and closed positions.
2. Because of fouling that can be caused by stringy material, non full port valves such as butterfly valves or plastic valves shall not be acceptable.
3. Each filter shall include one 2" solids waste valve. Valve shall be 2 piece, flanged end, ASTM A351 Grade CF8M stainless steel body, 316 stainless steel ball and stem, fullport, with a 115 volt, single phase, 60 Hz, open / close service electric actuator. Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal. Valve actuator shall include a compartment heater and limit switch feedback to the microprocessor in both the open and closed positions.
4. Each filter shall include a solids waste removal system consisting of perforated manifold, mounted on the floor of the filter basin. The manifold shall be designed to siphon settled solids for waste discharge through the backwash/waste pump. The operation of the solids waste removal system shall be automatic with user adjustable intervals and duration through the operator interface. Filters that are designed without a solids waste removal system will not be acceptable.

J. INFLUENT GATE

1. Each filter shall include one influent slide gate furnished and installed by the Contractor. See specification section 33 12 15 for details.

K. INFLUENT WEIR BOX

1. Each filter shall include a 304 stainless steel influent weir box. The weir box shall be mounted to the filter basin interior using 304 stainless steel wedge anchors and hardware. The basin wall must be smooth and plumb to facilitate a quality installation.
2. Filter systems without an influent weir box will not be accepted.

L. PUMP AND DRIVE MOTOR HEATERS

1. Pump and drive motor heaters with thermostats shall be included. Additional considerations for freeze protection, i.e. heat tape, etc., shall be the responsibility of others, as required.

M. PRESSURE TRANSDUCER

1. A submersible pressure transducer shall be supplied for each filter basin. The pressure transducer shall have stainless steel wetted parts and provide a 4-20 mA signal over a range of 0 psi to 5 psi. Units shall monitor the water level in the filter basin.
2. Pressure transducer shall be provided with a mounting bracket and stainless steel anchors.
3. A bellows providing vented gage atmospheric reference shall be supplied for contractor installation in junction box.
4. The installing contractor shall provide junction box, bellows mounting and interconnecting wiring. See specification section for 27 60 05 for details.

N. FLOAT SWITCH

1. A float switch shall be furnished to indicate emerging overflow level. See specification section for 27 60 05 for details.

O. VACUUM TRANSMITTER

1. The vacuum transmitter shall have stainless steel wetted parts and provide a 4-20 mA signal over a range of -30 to 0 inHg. Transmitter shall be an IFM Effector PX series or approved equal.

2.5 CONTROL SYSTEM

A. The automatic and manual controls for operation of the filter system shall be furnished fully assembled, wired and pre-programmed in a UL 508A Certified Industrial Control Panel. Controls shall be provided to control or monitor equipment as described in the contract drawings.

B. See specification section 26 29 00 for additional requirements.

C. The control system shall include the following control components and practices:

1. Control Panel Wiring and Assembly

a. All control enclosures shall be custom assembled and wired in an Underwriters Laboratories (UL) certified cabinet shop using quality materials and labor. Short circuit rating of control enclosure shall be 5 kA RMS symmetrical @ 480VAC maximum.
b. All control panel single conductor wire shall be 16 AWG multi-strand machine tool wire (MTW) minimum, with PVC insulation.
c. Wire colors are as follows:

208 VAC or higher	-	Black
120 VAC control power	-	Red
Neutral	-	White
Ground	-	Green with Yellow Stripe
Power from remote source	-	Orange
Neutral from remote source	-	White with Orange Stripe
24 VDC (+)	-	Blue
24 VDC (-)	-	White with Blue Stripe
Intrinsically Safe	-	Light Blue

d. Wire colors are as follows:

1) All wires shall be clearly marked with an identification number consistent with the wiring schematic drawing. Wire markers shall be a thermal transfer printable type. The material shall be a self-laminating vinyl. Labels shall be Brady THT-9-427-10 or approved equal.

e. Wiring inside the control panel shall be run in PVC wiring duct rated for continuous temperatures up to 122° F (50°C). Devices mounted in the enclosure door shall have wires run in spiral wrap to avoid pinch points when opening and closing the door.
f. Control components mounted internal and external to the enclosure shall be mounted with stainless steel hardware and clearly labeled with a plastic identification nametag. The tag shall be white with black lettering.

D. CONTROL PANEL

1. All Control panels shall be UL certified. Testing by manufacturer's electrical engineering prior to releasing for shipment shall be completed. Testing shall consist of the following:

a. Point to point testing of all wiring prior to application of power intended supply voltage shall be applied to the enclosure.
b. All components shall be tested for proper operation and calibration.
c. The PLC and operator interface program shall be loaded and functionally checked.
d. All components shall be checked to confirm proper mounting specifications have been followed
e. Enclosure shall be inspected for defects and repaired if necessary
f. All labeling of wires and devices are correct, properly installed and clean
g. The manufacturer shall finalize the factory checkout by completing a control panel checklist to document all testing completed above.

h. Upon the successful completion of the control testing of the enclosure assembly, all applicable documentation (i.e. finalized drawing set, signed control checklist cover page, device data sheets, etc.) shall be placed in the drawing pocket of the enclosure.

2. Electric Heater

a. An electric heater shall be provided inside the control enclosure to protect sensitive mechanical and electrical components from the harmful effects of condensation, corrosion and low temperatures. The heater is a thermostatically controlled, fan-driven unit. The heater shall be manufactured by Hoffman or approved equal.

3. Main Disconnect Circuit Breaker

a. A UL listed, automatic molded case 3-pole disconnect breaker shall be provided in the control enclosure(s). The primary function of the disconnect switch shall be to provide a means to manually open a circuit and automatically open a circuit under overload or short circuit conditions.
b. The disconnect breaker shall have a door mounted operating mechanism with trip indication.
c. Power distribution connectors shall be mounted integrally to the circuit breaker for multiple load connections. Integral connectors shall be provided. The disconnect circuit breaker shall be a Square D/HDL, JDL, LDL, MDL, PDL or approved equal.

4. Motor Starter

a. A full voltage non-reversing Integrated Motor Starter-Controller shall be provided for motor applications up to 15 kW. Each starter shall provide control, protection and monitoring functions for the motor. The starter shall be IEC rated and shall have certifications according to UL and CSA standards and shall bear the CE marking.
b. The starter shall have a maximum rated operational voltage of 690V and provide a 42kA @ 480 VAC rated breaking capacity on short circuit.
c. The starter shall have a mechanical durability of 15 million operations. The starter shall provide short circuit trip, thermal overload trip with selectable tripping class, under current trip and phase imbalance trip.
d. A full voltage non-reversing IEC Style motor starter shall be provided for motor applications over 15 kW.
e. Each starter shall consist of a circuit breaker, contactor and overload relay. The starter shall be IEC rated and shall have certifications according to UL and CSA standards and shall bear the CE marking.
f. The starter shall have a maximum rated operational voltage of 690V and provide a minimum 18 kA @ 480VAC and 25 kA @ 240 VAC interrupt rating on short circuit when used in combination with a PowerPact circuit breaker.
g. The starter shall have a mechanical durability of 15 million operations. The solid state overload relay shall have class 10 tripping characteristics with trip current adjustment, phase loss and unbalance protection.

5. Transformer

    a. A step-down multi-tap transformer shall be supplied when there is a necessity to reduce incoming 3-phase power to 120 VAC single-phase.
    b. The transformer power wire connections (incoming and outgoing) shall be protected with a finger-safe cover to protect against accidental contact. Primary and secondary fuse protection shall be provided.
    c. Transformer shall be UL listed and of continuous wound construction with vacuum impregnated with non-hygroscopic thermosetting varnish. Transformer shall be Square D 9070T or approved equal.

6. Transformer Primary and Secondary Fuse

    a. Properly rated fuses and fuse blocks shall be provided for primary and secondary protection of the transformer.
    b. Each fuse shall be equipped with a thermoplastic cover to protect against accidental contact.
    c. Clip style fuse block shall be rated up to 600 VAC and 100 amps, dual element, time delay fuses shall be rated up to 600 VAC.
    d. Fuse blocks and fuses shall be UL listed. F
    e. uses shall be Littelfuse Class CC or approved equal.
    f. Fuse blocks and fuse covers shall be manufactured by Marathon or approved equal.

7. Circuit Breaker

    a. All single phase branch or supplementary circuits shall be protected with a single-pole, C-Curve rated circuit breaker.
    b. Circuit breakers shall be rated for 240 VAC maximum, 50/60 Hz and UL 489 listed. Supplementary and branch protection circuit breakers shall be Merlin Gerin Multi 9 or approved equal.

8. Fuse

    a. Properly rated fuses and fuse holders shall be provided for protection of individual control devices (discrete and analog signals) mounted outside of the enclosure.
    b. Each fuse shall be housed in a hinged type fuse block to protect against contact with the fuse.
    c. Fuses shall be rated up to 250 VAC and be Littelfuse or approved equal.
    d. Fuse holders for discrete devices shall be rated to 600 VAC and 30 Amps.
    e. Fuse holders for analog devices shall be rated to 300 VAC and 15 Amps. Fuse holders shall be Allen Bradley 1492 or approved equal.

9. Operator Device

    a. Operator devices (pushbuttons and selector switches) shall be mounted through the control enclosure door for manual operation of the filter.
    b. Transformer type push-to-test LED pilot lights and illuminated pushbuttons shall be provided for indication of an operation status.

c. Lights shall be a 6 VAC incandescent type lamp. Color coding shall be applied as required and is as follows:

1) Amber – Alarm active, caution
2) Green – Valve open, motor running
3) Red – Valve closed
4) White – Information

d. All operator devices shall be UL Listed, 30.5mm style, NEMA Type 4X rated, oil and water tight with finger safe guards located on the contact blocks to prevent accidental contact with wire connections. Operator device function shall be identified with an engraved white Gravoply nameplate with black letters. Operator devices shall be Square D 9001 or approved equal.

10. High Frequency Noise Filter

a. A UL listed active tracking filter shall be provided to protect the PLC and HMI power feeds from high-frequency noise and low-energy transients.
b. It shall be designed for a single phase input voltage of 120VAC operating at 50/60 Hz. The unit shall provide surge capacity of 25,000 amps and provide transient protection in all modes (Line to neutral, line to ground and neutral to ground).
c. The noise filter shall be a SolaHD STFV or approved equal.

11. Ground Fault Duplex Receptacle

a. A UL listed ground fault circuit interrupter (GFCI) duplex receptacle shall be provided within the panel for instrument (e.g. programming terminal, modem, etc.) use only.
b. The receptacle shall be protected with a 5 Amp circuit breaker. The receptacle shall carry a 20A / 120VAC rating.
c. The electro-mechanical circuit interrupter shall be double-pole and trip free (GFCI protection and shall not be overridden by holding reset button). Built-in transient suppression shall protect GFCI's internal circuitry from voltage transients.
d. Receptacle shall be Hubbell DRUBGFI20 or approved equal.

12. 24 Volt DC Power Supply

a. Redundant UL listed, industrial grade, compact power supplies shall be supplied to provide 24 VDC power to such rated components.
b. The power supply shall be DIN rail mounted and functional with input voltage of 100 to 240 VAC (single-phase) incoming control power.
c. The power supply shall have a green LED which shall be illuminated when output voltage is "OK".
d. The power supply shall be an Allen Bradley 1606 or approved equal.

13. Control Relay

a. UL listed control relays for general control purposes shall be supplied with a pilot light to indicate when the coil is in an energized state. The relay socket shall be panel or DIN rail mounted inside the enclosure.
b. The relays shall provide the following ratings: 120VAC coil, 10A contact rating (thermal), 250 VAC insulation rating and 5 million mechanical life cycles.
c. Relays shall be Allen Bradley 700-HK, Square D, or approved equal.

14. Terminal Block

a. Standard feed-through screw terminal blocks, DIN rail mounted, shall be supplied for all point to point wiring connections.
b. All terminals shall be numbered per the wiring schematic with printed markers.
c. Terminals shall carry a 600V AC/DC voltage rating. Terminal blocks shall be Allen-Bradley 1492-J4 (35A max) and 1492-J16 (85A max) or approved equal.

15. Programmable Logic Controller

a. Automatic operation of the Filter shall be controlled through a programmable logic controller (PLC) mounted inside the main control panel.
b. The PLC components shall consist of a power supply, CPU, discrete input and output modules and analog input and output modules. The processor unit shall include built-in USB and two (2) Ethernet IP communication ports.
c. All input and output points supplied (including unused) shall be wired to terminal blocks.
d. Processor design characteristics shall include:
    1) 1.0MB user memory size, real-time clock and calendar, battery backed RAM and an operating temperature range between 32 °F and 140°F.
e. The PLC processor shall be an Allen-Bradley CompactLogix 1769-L30ER or approved equal.
f. Modular equipment shall be provided to complete the PLC system. These Allen-Bradley components include: 1769-PA4 – Power Supply, 1769-IA16 – Discrete input (16 point) modules, 1769-OW16 – Discrete output (16 point) modules and 1769-IF8 – Analog input (8 point) modules, 1769-OF4CI – Analog output (4 point) modules.

16. PLC Power Supply

a. Input voltage range of 85-265 / 170-265 VAC, 47-63 Hz, maximum inrush current of 30 amps, backplane output current of 4 amps @ 5V or 2 amps @ 24V, internal fuse protection, ambient operating temperature of 32°F to 140°F, Class I, Division 2 hazardous location certified, UL Listed.

17. Discrete Input Module

a. Operating voltage of 79 to 132 VAC at 47 to 63 Hz, backplane current draw at 5VDC = 115mA , off-state current 2.5mA maximum, maximum inrush current 250mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

18. Discrete Output Module

    a. Operating voltage of 5 to 265 VAC at 47 to 63 Hz / 5 to 125 VDC, backplane current draw at 5 VDC = 205mA , at 24VDC = 180mA, off-state current leakage is 1.0mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

19. Analog Input Module

    a. Backplane current draw at 5 VDC = 120mA, at 24VDC = 70mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

20. Analog Output Module

    a. Backplane current draw at 5 VDC = 120mA, at 24VDC = 170mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

21. Ethernet Switch

    a. An unmanaged Ethernet switch shall be provided inside the control enclosure to provide connectivity between the PLC, operator interface and plant networking.
    b. The switch shall support both 10 and 100 Mbit/s operation. The switch shall have five (5) 10/100Base-T ports with RJ-45 sockets and shall support auto-crossing, auto-negotiation and auto-polarity. Maximum distance between devices shall be 100m.
    c. The unit shall be DIN rail mounted and require 24VDC power. Diagnostic LEDs for power and connection status shall be included. The Ethernet switch shall be UL listed and manufactured by Allen-Bradley Stratix 2000 1783-US5T, or approved equal.
    d. Refer to Specification Section 26 29 00 (“Manufactured Control Panels”) for additional network connection requirements.

22. Human Machine Interface Overview

    a. The control system shall be equipped with a UL listed operator interface that provides control display screens. These screens shall be used by the operator to monitor and control filter status, setpoint and alarm information.
    b. The Interface shall allow the Operator access to adjust the following operating parameters:

        1) Backwash interval, Backwash duration, Sludge waste interval, Sludge waste duration, Number of backwashes between sludge wasting

    c. The operator interface shall provide information to assist the Operator in assessing the status of the filter system. The interface screen shall display, at minimum, the following parameters:

1) Water level in the filter, Time since last Backwash, Time since last Sludge withdrawal, Elapsed time on the Drive Motor, Elapsed time on the Backwash Pump(s), Total backwash time and cycles, Total sludge withdrawal time and cycles.

d. The interface shall display the alarm history. The alarm history shall include the time and date of the most recent 25 alarms along with the description of the alarm.
e. The interface shall also display current alarms, including the date, time and a description of the alarm.
f. As a diagnostic aid to the Operator, the interface shall display the time between backwashes for the most recent 40 backwashes.

23. Human Machine Interface

a. The operator interface shall be a NEMA Type 12, 13, 4X rated, 6.5” diagonal, color touchscreen display with Ethernet and serial communications. The interface shall be a liquid crystal display (LCD). The display type shall be color active matrix thin-film transistor (TFT) with 640 x 480 pixel resolution. The rated operating temperature shall be 32° to 131° F (0° to 55° C). The operator interface shall be an Allen Bradley PanelView Plus 7 Performance 7”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting the performance of equipment.

3.2 INSTALLATION AND OPERATION

A. Comply with the Manufacturer's detailed written instructions for installing grit system equipment.

B. Installation and operation shall be in accordance with instructions and recommendations provided by the Manufacturer.

C. The equipment Manufacturer shall furnish the services of a factory trained representative at the job site to monitor the installation, the initial operation of the equipment, and the instruction of the plant operating personnel in the proper operation and maintenance of this equipment. The cost of this service shall be included in the Contractor’s price for the performance of the work.

D. Verify that all units are in condition suitable for installation; are properly fitted, assembled, and installed; are accurately leveled and aligned, and are ready for satisfactory operation.

E. The Contractor shall finish coat with epoxy all submerged metal parts of the grit removal mechanism.

3.3 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition or replace them with new ones.

B. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer, that ensure equipment is without damage or deterioration at the time of Substantial Completion.

3.4 START-UP ASSISTANCE AND TRAINING

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train the Owner's maintenance personnel as specified below:

1. Factory authorized service representatives of the grit system Manufacturer shall perform all necessary on-site assistance for installation supervision.
2. Once the grit systems have been installed correctly and are operating as intended, the service representatives shall perform sixteen (16) hours of on-site start-up assistance and operator training for each type of pump.
3. Train the Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventive maintenance.
4. Schedule training with the Owner with at least seven days advance notice.

END OF SECTION 44 46 30

SECTION 46 00 00 - GRIT REMOVAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
B. Section 26 29 00 – Manufacture Control Panels

1.2 SUMMARY

A. This Section includes the following equipment:

1. Vortex Grit Collector
2. Grit Classifier
3. Grit Pump

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following.

1. Detail each equipment assembly, including make, model, rated capacities, furnished specialties, accessories, details of construction relative to materials, profiles, finishes, description of materials, bill of materials, motor data, pump data, the weight of each component, equipment structural design calculations, and process design calculations, description of surface preparation, shop priming, and finish painting, indicate installation details, dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
2. Power and control wiring diagrams, including terminals and numbers.
3. Equipment drive data including equipment assembly data, mounting details, grit collecting equipment locations, motor nameplate data per NEMA MG 1, and include any motor modifications.
4. Shop Drawings to include complete dimensional data, equipment outline dimensions, equipment drive data, equipment assembly data, mounting details, grit collecting equipment locations.

B. Product Test Reports: Based on evaluation of tests performed by Manufacturer and witnessed by a qualified independent professional engineer, indicate compliance of grit collecting equipment for applicable codes, based on comprehensive testing within the last two years of current products.

C. **Maintenance Data: For grit collecting equipment to include in the maintenance manuals specified in Division 1. Include the name, address, and telephone number of the Manufacturer's nearest authorized service representative.**

1.4 QUALITY ASSURANCE

A. The equipment specified herein shall be located as shown or described and installed in conformance with the Manufacturer's suggested method. The unit(s) shall be furnished

and installed with all necessary accessory equipment and auxiliaries, whether specifically mentioned in these specifications or not, and as required for an installation incorporating the highest standards for the type of service specified, including field technician representation during startup of the unit(s), and instruction of the Owner's personnel in the care, operation and maintenance of all equipment.

B. All equipment covered by these specifications shall be furnished by one Manufacturer, and shall be complete including motor and appurtenances. The equipment shall be the product of a single manufacturer regularly engaged in the production of equipment for the specified use. The Manufacturer shall have the sole responsibility for the proper functioning of the equipment as furnished.

C. Installer Qualifications: Engage an experienced installer who is an authorized representative of the grit collecting equipment Manufacturer for both installation and maintenance of the type of units required for this Project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and handle grit collecting equipment in a manner to avoid significant or permanent damage to equipment. Comply with pump Manufacturer's rigging instructions for handling and keeping the equipment stored in a clean, dry location free from construction dust, precipitation, and excess moisture.

1.6 WARRANTY

A. Warranty shall be provided per Specification Section 01 74 00.

1. Warranty shall be for unlimited usage of the equipment.
2. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the manufacturer shall provide and install a replacement part without cost to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Grit Removal System

1. Grit Collector
   a. Ovivo
   b. Smith and Lovelace

2. Grit Classifier
   a. Ovivo
   b. Smith and Lovelace

3. Grit Pump – Gorman Rupp Self-priming T-Series or equal.

2.2 DESIGN REQUIREMENTS

A. The grit will be separated from the wastewater in the upper section of the existing chamber and collected in the lower storage hopper. The floor of the upper section shall

be sloped to enable the grit to fall by gravity to the storage hopper. Systems that offer a flat floor that hydraulically scour by the action of a four bladed propeller will not be acceptable.

B. The system will be able to guarantee to remove grit as specified below at the hydraulic peak flow rate with no decrease in efficiency at flows less than the design capacity. The manufacturer must be able to offer a proven test procedure that can be applied following installation.

Peak flow per chamber	12 MGD
Average flow per chamber	6 MGD
Head loss at peak flow	1 Inch MAX
Operational performance guarantee	
Grit greater than 50 mesh	95%
Grit greater than 70 mesh but less than 50 mesh	85%
Grit greater than 100 mesh but less than 70 mesh	75%

C. There shall not be any moving parts subject to wear or stoppage below the water storage hopper. It shall not be acceptable to include mechanical fluidizer vanes or any other moving part in the storage hopper.

2.3 GRIT COLLECTOR

A. General

1. The grit removal system will operate on the vortex principle. The system must be compatible with the existing concrete chamber. The Contractor and Manufacturer shall confirm the existing concrete chamber is adequate for supporting the equipment and that the configuration of the chamber and inlet and outlet channels are adequate for the removal of grit as specified in this section. The equipment manufacturer will supply a geared drive assembly that will be centrally mounted by the Contractor on the existing support bridge. The Contractor and Manufacturer shall confirm the existing support bridge is robust enough to fully support the drive tube and impeller that will be in continuous operation.
2. The internal rotating mechanism will be a flat plate impeller that is specifically designed to separate sewage solids so that the heavy grit falls by gravity into the storage hopper and the light organic solids and rags are rejected out of the upper chamber into the outlet channel.
3. The 4-inch diameter grit suction pipe will be an integral part of the grit removal system running from the storage hopper up through the drive tube and drive head and terminate in the top of the drive unit with a 4” flange for connection to the grit pump.
4. The 1.5-inch diameter grit fluidizing pipe will run parallel with the suction pipe from the storage hopper to terminate with a solenoid valve above the drive head. The Contractor will connect this point to the plant water supply and provide a stainless steel ball valve for isolation. The contract shall provide heat tracing and insulation to prevent the fluidizing line from freezing.

5. The equipment Manufacturer will have at least 1,000 completed installations and 25 years of experience manufacturing vortex grit systems.

B. Mechanical Geared Drive Assembly:

1. The gear head shall comprise of a heavy duty gray iron base and cover securely bolted together to form a composite unit. The base section shall support a 21 inch turntable bearing, designed to protect against any distortion, and that has a minimum B-10 life of 20 years.
2. The drive tube is rotated at no more than 13 rpm by a heavy duty iron spur tooth bull gear wheel securely bolted to the turntable bearing. This bull gear is driven by a steel drive pinion mounted on the output shaft of the helical gear motor. An alloy cover designed to support the helical gear motor will have an access located to ensure that the gear wheel and pinion are correctly centered. The pinion and the bull gear will have a service factor of 5.0 or greater at standard operating speeds.
3. The bull gear will have an opening for the 10.75-inch drive torque tube that rotates the impeller. The gearbox shall be sealed and the bottom opening will include an air bell around the drive torque tube to prevent the ingress of water into the gearbox.
4. The whole geared drive assembly shall be suitable for daily 24-hour service.

C. Impeller:

1. The impeller is located between the upper section of the chamber and the lower storage hopper. There shall be a 2-inch gap between the outer edge of the impeller and the tank wall to allow the free passage of the grit particles.
2. The impeller is only supported and driven by the drive torque tube and no other attachment points will be permitted.
3. The impeller will be a single flat disc plate with 304 Stainless Steel adjustable blades. These vanes will be inclined back against the flow to create the radial forces necessary to ensure that grit particles fall by gravity to the storage hopper and a gentle upward current to eject light solids from the tank. Systems with axial flow propellers rotating faster than 13 rpm and a separate cover plate over the storage hopper will not be acceptable.
4. The impeller will have a 4-inch opening behind each inclined vane which will allow light solids to re-enter the upper chamber following washing in the storage hopper.
5. The impeller shall be supplied in two sections and shall be clamped to the drive tube. The performance of the impeller is adjustable by re-setting the vertical position of the impeller on the drive tube.
6. The impeller and the drive tube shall be fabricated from 304L Stainless Steel.

D. Suction Pipe

1. The 4-inch diameter suction pipe will run from the storage hopper into a self-primping grit pump mounted on the bridge. The suction end must be at least 4 inches from the chamber floor to prevent the chance of blockage.
2. The suction pipe will be straight and will lift through the drive tube and the drive head and directly into the pump. It shall not be supported off the chamber wall.

E. Grit Fluidizing

1. The Contractor shall supply and install a 1.5-inch diameter pipe that runs parallel with the 4-inch suction pipe and terminates in the storage hopper of the vortex grit chamber as shown on the contract drawings.
2. The Contractor will connect the pipe to a plant water supply that can provide a 35-45 GPM @ 60 PSIG at the suction point. This will fluidize and agitate the settled grit for two (2) minutes before each pumping cycle.
3. The Manufacturer shall supply a 1.5-inch solenoid valve (with an explosion-proof rating) and two (2) manual isolation valves for installation by the Contractor as shown on the contract drawings.
4. The Manufacturer will control the solenoid valve and therefore the fluidizing cycle through the grit pump control panel described herein.

F. Grit Collector Motor

1. The grit removal drive motor shall be an integral part of the geared motor that is directly shaft mounted to the gear wheel within the gear head.
2. The motor shall be a 1 HP, 1760 RPM, TEFC, helical gear, designed for a 460 Volt, 3 phase, 60 Hz power and be suitable to operate in Class1 Division 1 Group D environment.
3. Motor starter shall be FVNR.

2.4 GRIT PUMP

A. General

1. Pump shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage. Pump solids handling capability per the performance criteria below.
2. The pump shall be mounted on a vertical V-Belt Base suitable for a 15 HP motor, 460V/3Phase/60Hz power, suitable to operate in Class1 Division 2 Group D environment.

B. Manufacturer

1. Pump shall be Gorman Rupp T-Series, T4 or equal.

C. Performance Criteria

1. Pumps must be designed to handle raw, unscreened, domestic sanitary sewage.
2. Pumps shall have a 4" suction connection, and 4" discharge connection. The pump shall be selected to perform under the following operating conditions:

a.	Capacity (GPM)	250
b.	Total Dynamic Head (FT)	28

D. Materials and Construction Features

1. Pump shall be mounted on a fabricated steel base consisting of pump, motor, V-belt drive unit, and belt guard.

2. The pump motor shall be horizontal, TEFC, inverter duty type, with normal starting torque and low starting current characteristics, suitable for operation on 460 volt, 3 phase, 60 Hz electrical service. The motor shall be non-overloading over the entire operating range of the pump. Each motor shall be of NEMA design cast iron frame with copper windings.
4. Motor starter shall be FVNR.
3. Power shall be transmitted from the motor to the pump using a V-belt drive assembly. The drive assembly must be selected to establish proper pump speed to meet the specified operating conditions. The drive assembly shall have a minimum of two belts, and provide a safety factor of no less than 1.5 (BHP to motor HP). Computation of safety factors shall be based on performance data published by the drive manufacturer, and copies of drive selection computations shall be included as part of the submitted data for approval by the engineer.
4. Pump drive transmissions shall be enclosed on all sides in a guard constructed of any one or combination of materials consisting of expanded, perforated, or solid sheet metal. Expanded or perforated openings shall not exceed 1". The guard shall be manufactured to permit complete removal from the pump unit without interference with any unit component.
5. Pump shall be mounted on a fabricated steel base consisting of pump, motor, V-belt drive unit, and belt guard.
6. The pumps and exposed steel framework shall be cleaned with an industrial grade chemical cleaner. The prime coat shall be a zinc base synthetic primer and the finish coat shall be an automotive grade acrylic enamel.
7. Pump casing shall be grey cast iron No 30
8. Bearing Housing shall be grey cast iron No 30
9. Removable cover plate shall be grey cast iron No 30
10. Replaceable wear plate shall be steel No 1018
11. Pump shall have an integral suction check valve. The suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect the pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the cover plate opening, without disturbing the suction piping. The sole function of the check valve shall be to save energy by eliminating the need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.
12. Pump shall be provided with a thermostat mounted to the exterior of the volute casing, and a 750 watt 115-volt electric heater inserted into the interior of the volute using a dedicated port. The heater shall be energized at 43+/-3 degrees F to provide heat to the casing and eliminate the possibility of freezing. Heater probes that must be installed through a pump drain port shall not be acceptable.

2.5 GRIT CYCLONE and SCREW CLASSIFIER

A. Design Requirements

1. The grit cyclone and screw classifier will be an integrated package for separating grit from water and other solids and to discharge a relatively dry grit into a dumpster. The system offered will be fully compliant with the following design criteria and the contents of this specification section.

Number of grit cyclones	One (1)
Maximum inflow to cyclone	300 GPM

Inlet pressure range	7-12 psi
Inlet pipe	4 inches
Overflow outlet pipe	6 inches
Vortex finder	3.5 inches
Underflow outlet cone	4 inches
Average underflow to the classifier	20 GPM
Number of screw classifiers	One (1)
Maximum classifier capacity	100 GPM
Diameter of screw	6 Inches
Washwater	NA
Length of screw	>14 Feet
Speed of screw	10-12 rpm

2. The manufacturer will provide all necessary information to ensure that the equipment will be coordinated to work in conjunction with the grit chamber and grit removal equipment.

B. General

1. The grit cyclone will be installed at the end of the 4-inch pumping main and will be mounted on top of the screw classifier hopper. The complete system will be capable of receiving the specified maximum pumped flow rate of wastewater containing grit directly from the selected grit chamber. The equipment will be capable of separation so that the wastewater containing light organics is returned to the flow and the mineral grit is elevated to a point where relatively dry grit can fall by gravity into a dumpster.
2. The equipment manufacturer will have at least 1,000 completed installations and 25 years of experience supplying vortex grit systems.

C. Grit Cyclone

1. General
   a. There shall be furnished one (1) hydrocyclone degritting device(s). The cyclone shall be designed to remove at least 95% of the grit entering the feed inlet that is larger than 150 mesh and having a specific gravity of 2.65 or greater. The cyclone shall have 300 GPM capacity at 12 PSIG pressure drop; the feed chamber diameter shall be 10" and be fabricated with an involuted feed entry with standard 4" flanged inlet connection and 6" overflow flanged connection.
   b. The equipment shall be the product of a manufacturer who has made equipment of comparable design and capacity for at least five (5) years. The hydro cyclone shall be a Model D10 as manufactured by Krebs Engineers. Equipment of different designs must be submitted to the Engineer for his written approval before it can be considered for the application.

2. Equipment Details

   d. The hydro cyclone shall be fabricated of cast and fabricated steel. It shall be equipped with a long sweep involuted feed entry and have replaceable

neoprene liners in the inlet head cylindrical and conical sections. The vortex finder shall be cast Nihard and easily replaceable. The apex valve and lower conical section shall be hinged to allow access for cleanout without disconnecting any piping. The apex insert shall be replaceable and shall be manually adjustable. An inlet pressure gauge and diaphragm assembly are to be provided for installation on the inlet flanged adapter, and lifting eye bolts are to be included to facilitate handling and installation of the equipment.

3. Support

    d. A structural steel support frame shall be provided to hold and support the cyclone unit.

D. Screw Classifier

1. The grit and water mixture will enter the screw classifiers 304L Stainless Steel flared inlet hopper that shall provide adequate volume to ensure that the inflow grit and water mixture has sufficient retention time for full separation of the heavy grit from the water and residual light organic solids. The inlet hopper will contain one overflow weir to drain off the water which will be adjustable to allow precise control of the floatation and removal of light organic solids and to minimize the carryover of fine grit. There shall be no parallel plate separators or other restrictions inside the hopper that can accumulate solids and inhibit performance. The back of the hopper will be fitted with a 2-inch diameter drain connection.
2. The grit will be elevated from the hopper by a 6-inch diameter 304 stainless steel screw with windings formed from 1/4-inch-thick plate rotating in a ¼ inch thick 304 stainless steel U-shaped trough set at a 20-degree angle. The dewatered grit will drop from the plain end pipe outlet into the dumpster. The screw classifier will be self-standing with 304 stainless steel support legs.
3. The screw is held between top bearings leaving a 5/8 gap between the screw flights and trough. A protective lining of grit will build up in this space and prevent wear to the equipment. The top end of the screw will be flanged to facilitate the removal of the screw.
4. The top of the flights and screw will be supported radially by the reducer internal bearings.
5. The open area of the hopper and trough will be covered with an open mesh cover.
6. The screw classifier design offered will not require any wash water to be added to enhance performance.

E. Motors

1. The drive motor shall be an integral part of the geared motor that is directly shaft mounted to the gear wheel within the gear head.
2. Each motor shall be a 1.0 HP designed for a 460Volt, 3 phase, 60 Hz suitable to operate in Class1 Division 2 Group D environment.
3. Motor starter shall be FVNR.

2.6 CONTROLS

A. The following controls shall be supplied with the grit dewatering equipment.
   1. The electrical control panel for the grit removal drive, grit pump, and all miscellaneous electrical items associated with the operation of the grit removal system shall be furnished by the equipment supplier and installed by the contractor.
   2. Provide a totally enclosed, front access type, 460-volt control panel with a NEMA 4X, 304stainless steel enclosure. The manufacturer's control panel shall be furnished in strict accordance with Section 26 29 00 ("Manufactured Control Panels").
   3. All controls shall be manufactured by a UL508 certified company.
   4. The control panel wiring shall be neatly cabled and supported in non-flammable wiring raceways.
   5. The panel shall include the following at a minimum:
   6. Starters for all motors
   7. Circuit breakers
   8. PLC Controller:
      a. The operation of the Grit Removal system is managed at the control panel by a PLC-based controller which continuously monitors and controls the system functions. PLC shall be Allen Bradley Micro 800 or CompactLogix series. PLCs and I/O modules should be in an active life cycle status at the time of installation.
      b. An operator interface display screen (Allen Bradley Panelview type) shall be provided on the front of the panel. This display shall be menu-driven with automatic fault message windows appearing upon alarm conditions. Operator Interface shall be color and a minimum of 7" square.
      d. All control devices and switches required for good quality operation shall be supplied in the control panel.
      e. Miscellaneous items required to operate the grit removal equipment.
      f. The following dry contacts (for remote SCADA monitoring):
         1) On/Off Status for each starter
         2) Alarm/overload Status for each starter
         3) General Alarm status for the system
      g. The electrical control panel shall include a thermostatically controlled strip heater to prevent condensation formation.
      h. The control equipment shall be mounted in a NEMA 4X stainless steel weatherproof enclosure.
      i. All controls shall be manufactured by a UL508 certified company.

2.7 EMERGENCY STOP LOCAL PUSH BUTTON STATION

A. A NEMA 7 (Class I, Division II hazardous-location-rated) emergency stop push button station shall be provided by the equipment supplier, to be mounted adjacent to equipment as shown on plans.

2.8 OPERATION

A. The screw classifier will take signal from the grit pump to start and will run throughout the pumping cycle.
B. The screw classifier will run after the conclusion of the pumping cycle for 0-15 minutes.

2.9 IINSTALLATION

A. Install equipment per the approved shop drawings and the manufacturer's installation instructions.
B. Final electrical connections are to be made by the electrical contractor.

2.10 FIELD QUALITY CONTROL

A. A manufacturer provided service person shall be on-site for one (1) trip lasting a minimum of one (1) day to perform the following services.
   1. Equipment Installation
      a. Inspect the completed installation and note any deficiencies.
      b. Complete and provide the OWNER with a copy of an installation report.
   2. Equipment Start-up
      a. Assist in placing the system of equipment into proper operation making any necessary recommendations and adjustments.
      b. Provide OWNER with a copy of the start-up report.
   3. Equipment Training
      a. Instruct plant personnel in the operation and maintenance of the equipment system specified herein.
      b. Training sessions shall include, but not be limited to, a classroom session and a hands-on session.

2.11 SPARE PARTS AND SAFETY EQUIPMENT

A. The following spare parts and safety equipment shall be provided as a minimum. The spare parts shall be provided after the equipment has been installed and successfully started up to ensure that the quantities of the parts indicated below will be available to plant personnel and not used during the installation or start up processes. Storage of the parts before that time shall be the responsibility of the Contractor.

B. Grit System:

   1. Contractor shall furnish to the Owner one set of all special tools required for the proper servicing of all equipment supplied under these specifications.
   2. Contractor shall furnish all spare parts, not including required lubrication as recommended by the manufacturer for one year's normal operation and maintenance of the equipment.
   3. Grit classifier nylon lower bearing shall be provided.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting the performance of equipment.

3.2 INSTALLATION AND OPERATION

A. Comply with the Manufacturer's detailed written instructions for installing grit system equipment.

B. Installation and operation shall be in accordance with instructions and recommendations provided by the Manufacturer.

C. The equipment Manufacturer shall furnish the services of a factory trained representative at the job site to monitor the installation, the initial operation of the equipment, and the instruction of the plant operating personnel in the proper operation and maintenance of this equipment. The cost of this service shall be included in the Contractor's price for the performance of the work.

D. Verify that all units are in condition suitable for installation; are properly fitted, assembled, and installed; are accurately leveled and aligned, and are ready for satisfactory operation.

E. The Contractor shall finish coat with epoxy all submerged metal parts of the grit removal mechanism.

3.3 CLEANING AND PROTECTING

A. Restore marred, abraded surfaces to their original condition or replace them with new ones.

B. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer, that ensure equipment is without damage or deterioration at the time of Substantial Completion.

3.4 START-UP ASSISTANCE AND TRAINING

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train the Owner's maintenance personnel as specified below:

1. Factory authorized service representatives of the grit system Manufacturer shall perform all necessary on-site assistance for installation supervision.
2. Once the grit systems have been installed correctly and are operating as intended, the service representatives shall perform sixteen (16) hours of on-site start-up assistance and operator training for each type of pump.
3. Train the Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventive maintenance.
4. Schedule training with the Owner with at least seven days advance notice.

END OF SECTION 46 20 40